APR 15 1948

FACTORY
MANAGEMENT AND MAINTENANCE

APRIL 1948

IN TWO PARTS—PART ONE

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Fourteenth Annual Presentation

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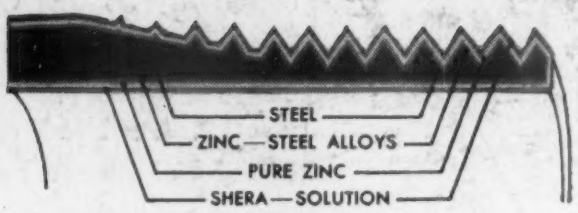

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APRIL, 1948—in two parts, part one

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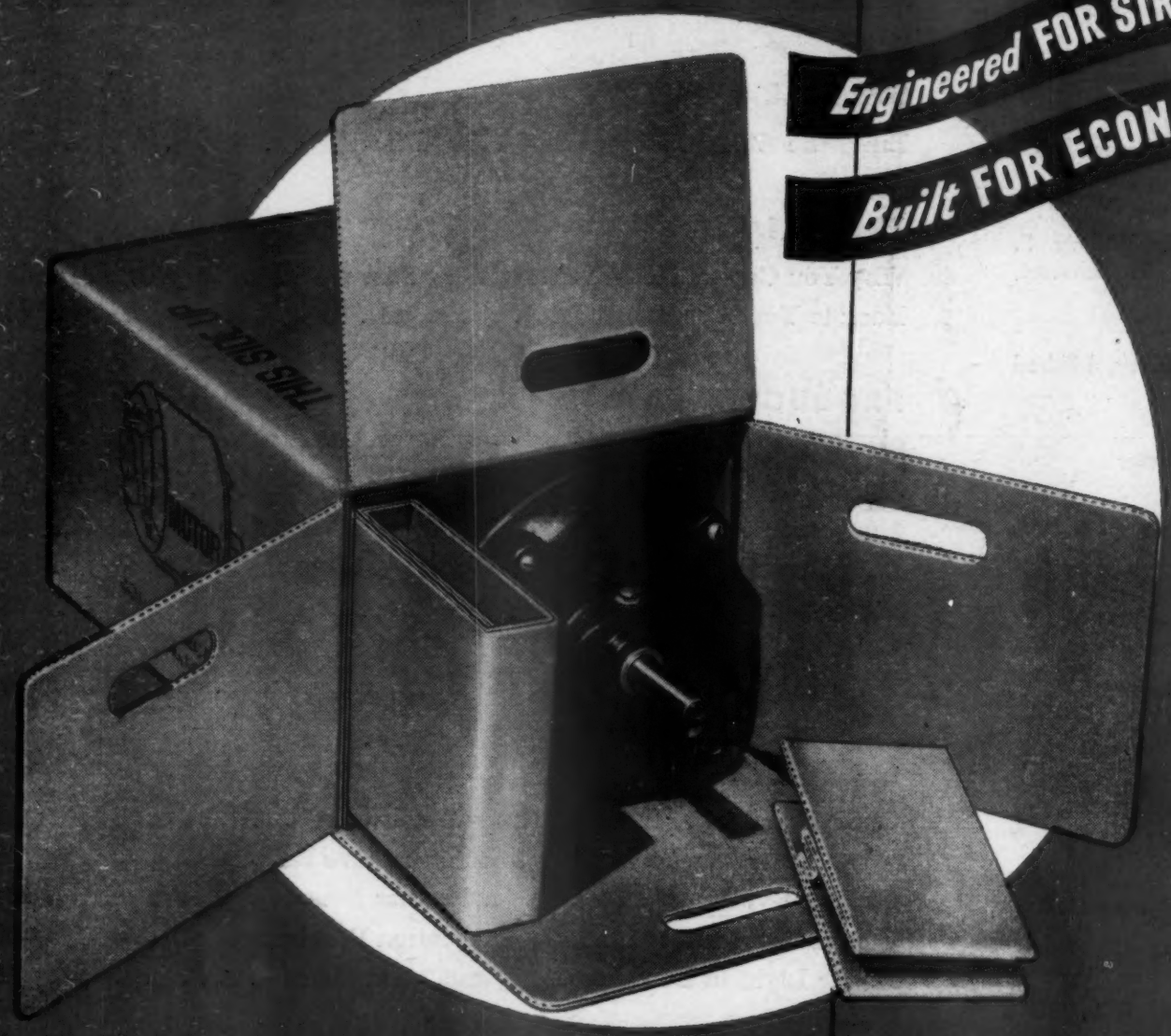
PART TWO OF THIS ISSUE

Industrial Plant Buildings—(*Fourteenth Annual Presentation*)

H & D BOXES



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Communique No. 1, "What We Are Doing About National Security," was published in the March, 1948, issue of FACTORY (page 66); Communique No. 2, "Build the Stockpile Now for National Security," appears on page 50 of this issue. Additional communiques will be issued as occasion warrants, either in the form of last-minute inserts, similar to this one, or as full-length feature articles

OPINIONS AND FACTS ABOUT INDUSTRIAL MOBILIZATION

• During the last week in March, many people of national reputation appeared before the Senate Armed Forces Committee to testify on the President's proposals for Universal Military Training and a temporary Selective Service. Several witnesses called attention to the need for industrial mobilization to "back up" any program of manpower preparedness: Presidential Adviser Bernard M. Baruch and Charles E. Wilson, president of General Electric and former head of the War Production Board, testified. Both asserted that adequate plans for industrial mobilization are needed *now*. Excerpts from their statements appear below.

Even though over-all plans have not yet been formulated, the armed services have organized industrialization and procurement planning offices where industrialists may go for information about future plans, educational orders, and prototype orders. Actual contracts for educational and prototype orders, however, are placed only after they have been cleared by the Research and Development Board, which includes technical representatives of all the services. A somewhat parallel group of offices has been established to handle inquiries regarding current needs for equipment and supplies. A geographical list of these offices forms a part of this communique.

Don't go to Washington. In order to avoid confusion by overloading headquarters personnel, action should be initiated through the local offices.

What the Experts Say Should Be Done

BERNARD M. BARUCH: "We should deceive ourselves by relying on any single measure of defense. . . An adequate defense must be a balanced defense, with all its varied elements integrated into one whole.

"There must be a ready-to-go plan for the full mobilization of the nation. Such a program should be enacted into law now, with the understanding that it would come into effect by proclamation of the President with the concurrence of Congress. . .

"Such a mobilization plan should cover:

"1. A system of industrial mobilization with priorities, allocations, and rationing powers.

"2. A ceiling over all wages, prices, and rents, to prevent inflation.

"3. Taxation to take the profit out of war.

"4. The accumulation of strategic raw materials which may be lacking or in short supply.

"5. A work-or-fight wartime draft.

"6. The organization of pools of labor of all kinds and in all professions and sciences.

"7. Intensified scientific research.

"8. Expanded intelligence, information services.

"9. Retention of war plants in standby readiness.

"10. Decentralization of industry to guard against an over-concentration which could be a strategic liability.

"11. Up-to-date surveys of underground industrial facilities.

"12. Uniform war contracts.

"Resistance of vested habit may seek to block an industrial mobilization plan. Different groups may refuse to agree now on the restraints and disciplines they would have to accept in case of another war. . . All may clamor 'Let us wait and see' whether or not these things are really necessary when the emergency comes.

"This 'wait and see' habit, so deeply ingrained in our natures, must be broken if we are to use America's power effectively to prevent war. . .

"That is the choice before this country today. Shall we mobilize *now* for peace? Or, in letting slip precious time, will we leave ourselves no alternative but to mobilize for *war in the future*?"

CHARLES E. WILSON (of General Electric): "If we are to act intelligently to meet the crisis of this hour, we must have a program adapted to the magnitude of our danger. . .

"As soon as the necessary measures have been adopted to assure the adequate restoration of our armed forces, that program should be implemented by the adoption of the other suggestions of the Compton Commission. [Report of the President's Advisory Commission on Universal Training: May 27, 1947.] These as you will recall, are the recommendations for industrial mobilization, the stockpiling of critical materials, and a program of scientific research and development. . .

"This nation has twice indulged itself in the luxury of unpreparedness. Because of our strong allies and the advantages of our geographical position, we were previously spared from the tragic consequences which might logically have followed from our folly. Today we see the very existence of our allies endangered; our geographical defenses are obsolete. To impress both the aggressor nations and the oppressed with the fact that we now recognize our national responsibility, it is our duty to take those steps . . . necessary to establish a preparedness policy commensurate with our obligations as measured by the dangers of the hour."

Under questioning by members of the Armed Forces Committee, Mr. Wilson made these additional points:

If the cost of the national defense program reaches $20 billion per year, "then I think you are going to need some controls."

Wage, price, and allocation controls should be imposed simultaneously "as soon as the volume [of spending] got to some point where it was bound to cut across the civilian economy . . . otherwise we will waste a great deal of money and time." When this point is reached, the National Security Resources Board will need the power "to take certain industries and convert them."

Asked if the nation could maintain a "solvent economy" in the face of a $25 billion annual "peacetime" defense appropriation, Mr. Wilson replied, "I do not regard these as peace times . . . The payment . . . is going to be painful."

Who Plans for Future Buying for Army and Air Force

LOCATION	OFFICE DESIGNATION	TELEPHONE NO.
ATLANTA		
Atlanta General Distribution Depot U. S. Army 50 Whitehall Street	Atlanta QM Industrial Mobilization District Atlanta Procurement Office, Corps of Engineers	Calhoun 5461 Cypress 3661
BIRMINGHAM		
Birmingham Ordnance District 700 Frank Nelson Bldg.	Ordnance Industrial Mobilization and Procurement Planning Office	4-7511
BOSTON		
Boston Ordnance District Rooms 1501-1516, 140 Federal St.	Ordnance Industrial Mobilization and Procurement Planning Office	Hubbard 9800
Boston Quartermaster Depot Army Base 18 Tremont Street	Boston QM Industrial Mobilization Office Boston Air Force Procurement Field Office	Liberty 6000 Capitol 9700
BROOKLYN		
Navy Medical Supply Depot 84 Sands Street	C.O., ANM Procurement Office, Industrial Mobilization and Procurement Planning Division	Main 5-4581 Ext. 93
CHICAGO		
39 S. LaSalle Street	Chicago Air Force Procurement Field Office	Randolph 9720
158 W. Harrison Street	Chicago Chemical Procurement District	Harrison 4390
158 W. Harrison Street	Chicago Procurement Office, Corps of Engineers	Harrison 4390
1660 E. Hyde Park Blvd.	Chicago Ordnance District, Ordnance Industrial Mobilization and Planning Office	Butterfield 5800
1619 W. Pershing Road	Chicago QM Industrial Mobilization Planning Office	Lafayette 5500

LOCATION	OFFICE DESIGNATION	TELEPHONE NO.
CINCINNATI		
Big Four Bldg.	Cincinnati Ordnance District, Ordnance Industrial Mobilization and Planning Office	Cherry 3800
CLEVELAND		
6200 Riverside Drive	Cleveland Ordnance District, Ordnance Industrial Mobilization and Planning Office	Clearwater 7700
COLUMBUS		
Columbus General Distribution Depot U. S. Army	TC Field Industrial Mobilization Planning Unit	Douglas 1811
DALLAS		
Room 518, 1114 Commerce Street	Dallas Chemical Procurement District	Riverside 6951
Room 204, 1114 Commerce Street	Dallas Sub-Office of Chicago Air Force Procurement Field Office	LD 930 Ext. 797
DAYTON		
Wright Field	Hq. Air Material Command, Director Procurement and Industrial Mobilization Planning, Industrial Mobilization Planning Division	Kenmore 7111 Ext. 2-2200
Wright Field	Dayton Air Force Procurement Field Office	Kenmore 7111 Ext. 3-9214
DETROIT		
W. Warren & Lonyo Avenues	Detroit Air Force Procurement Field Office	Hogarth 8730
Center Line, Mich.	Detroit Ordnance District, Ordnance Industrial Mobilization and Planning Office	Detroit Plaza 3700
Center Line, Mich.	Detroit Arsenal	Detroit Plaza 3700
DOVER, N. J.	Picatinny Arsenal	6-0711
EDGEWOOD, MD.		
Building No. 1 Army Chemical Center	Chief, Chemical Corps Supply and Procurement Div., Procurement Branch, Procurement Planning Section	Edgewood 1000 Ext. 5155
LOS ANGELES		
P. O. Box 3849, Terminal Annex 3636 Beverly Blvd.	Los Angeles Air Force Procurement Field Office	Drexel 7081
25 N. Raymond Avenue Pasadena 1	Ordnance Industrial Mobilization Planning Office, Los Angeles Ordnance District	
NEW YORK		
67 Broad Street	N. Y. Air Force Procurement Field Office	Whitehall 4-1600
111 E. 16th Street	N. Y. Chemical Procurement District	Gramercy 7-4700
120 Wall Street	N. Y. Procurement Office, Corps of Engineers	Whitehall 4-5500
111 E. 16th Street	Ordnance Industrial Mobilization Planning Office, N. Y. Ordnance District	Gramercy 7-4700
111 E. 16th Street	N. Y. QM Industrial Mobilization Planning Office	Gramercy 7-4700, Ext. 124
OAKLAND		
Chicago QM Purchasing Office Western Branch Oakland Army Base	Oakland QM Industrial Mobilization District	Twin Oaks 4100
PHILADELPHIA		
Bldg. No. 11 Frankford Arsenal	Ordnance Industrial Mobilization Planning Office, Philadelphia Ordnance District	Jefferson 5-2935
Bridesburg Station	Frankford Arsenal	Jefferson 5-2935
Philadelphia QM Depot 2800 S. 20th Street	Philadelphia QM Industrial Mobilization District	Howard 5-2000
2800 S. 20th Street	Industrial Mobilization Division, Signal Corps Procurement District	Fulton 9-7000 Ext. 242
PITTSBURGH		
925 New Federal Bldg.	Pittsburgh Procurement Office, Corps of Engineers	Grant 0800
1202 Chamber of Commerce Bldg.	Ordnance Industrial Mobilization Planning Office, Pittsburgh Ordnance District	Grant 5966
ROCHESTER		
Sibley Tower Bldg.	Ordnance Industrial Mobilization Planning Office, Rochester Ordnance District	Stone 3203
ROCK ISLAND, ILL.	Rock Island Arsenal	8000
ST. LOUIS		
1114 Market Street	St. Louis Procurement Office, Corps of Engineers	Garfield 0360

LOCATION	OFFICE DESIGNATION	TELEPHONE NO.
4800 Goodfellow Blvd.	Ordnance Industrial Mobilization Planning Office, St. Louis Ordnance District	Evergreen 3011
SAN FRANCISCO		
Building 141 Ft. Mason	San Francisco Chemical Procurement District	West 6111 Ext. 4387 & 4425
74 New Montgomery Street	San Francisco Procurement Office, Corps of Engineers	Yukon 6-0667
100 McAllister Street	Ordnance Industrial Mobilization Planning Office, San Francisco Ordnance District	Underhill 3306
SPRINGFIELD, MASS.		
Springfield Armory	Ordnance Industrial Mobilization Planning Office, Springfield Ordnance District	7-4381
Springfield 1	Springfield Armory	7-4381
WATERTOWN, MASS.		
Watertown 72	Watertown Arsenal	8540
WATERVLIET, N. Y.	Watervliet Arsenal	886
WASHINGTON, D. C.		
Room 4C 1071 The Pentagon	Department of Air Force, Deputy Chief of Staff, Material Director, Procurement and Industrial Planning, Industrial Planning Division	Republic 6700 Ext. 3618
Room 4D 567 The Pentagon	Office of Chief of Chemical Corps, Supply and Procurement Division, Procurement Branch	Republic 6700 Ext. 5407 & 74668
Building T-7 Gravelly Point, Va.	Office of Chief of Engineers, Procurement Division, Military Supply and Procurement	Republic 6700 Ext. 5273
Room 2E 448 The Pentagon	Office of Chief of Ordnance, Industrial Division	Republic 6700 Ext. 5371 & 5372
Tempo A. Bldg. 2nd & T Sts., S.W.	Office of Quartermaster General, Military Planning Division, Planning Branch, Industrial Mobilization Planning Section	Republic 6700 Ext. 2365
Room 2E 540 The Pentagon	Office of Surgeon General, Industrial Mobilization Procurement Planning Section	Republic 6700 Ext. 72817 & 74137
Room 4C 285 The Pentagon	Office of Chief Signal Officer, Industrial Mobilization Branch, Procurement and Distribution Division	Republic 6700 Ext. 3879
Room 3A 510 The Pentagon	Office of Chief of Transportation, Industrial Mobilization Planning Unit Supply Division	Republic 6700 Ext. 6949
U. S. Navy Dept. Constitution Ave. & 18th St., N.W.	Director of Material Division, Office of The Assistant Secretary, U. S. Navy	Republic 7400 Ext. 4072

Who Buys Current Equipment and Supplies for Army and Air Force

CHEMICAL CORPS

Commanding Officer, Chemical Corps Procurement Agency, Army Chemical Center, Md.

CORPS OF ENGINEERS

Chicago Procurement Office, Corps of Engineers, 158 W. Harrison St., Chicago 5

Atlanta Lumber Branch Office, Corps of Engineers, P. O. Box 1889, Atlanta 1

Portland Lumber Branch Office, Corps of Engineers, 628 Pittock Block, Portland 5, Ore.

MEDICAL DEPARTMENT

Army-Navy Medical Procurement Office, 84 Sands St., Brooklyn 1

ORDNANCE DEPARTMENT

Aberdeen Proving Ground, Aberdeen, Md.

Detroit Arsenal, Center Line, Mich.

Frankford Arsenal, Philadelphia

Picatinny Arsenal, Dover, N. J.

Raritan Arsenal, Metuchen, N. J.

Rock Island Arsenal, Rock Island, Ill.

Springfield Armory, Springfield, Mass.

Watertown Arsenal, Watertown, Mass.

Watervliet Arsenal, Watervliet, N. Y.

QUARTERMASTER CORPS

New York Quartermaster Purchasing Office, 111 E. 16th St., New York 3

Chicago Quartermaster Purchasing Office, 1819 W. Pershing Rd., Chicago 9

Boston Quartermaster Purchasing Office, Army Base, Boston 10

Columbus General Disposition Depot, Columbus, Ohio

Jeffersonville Quartermaster Depot, Jeffersonville, Ind.

Philadelphia Quartermaster Depot, 2800 S. 20th St., Philadelphia 45

Headquarters, Quartermaster Market Center, Chicago

Joint Army-Navy Petroleum Purchase Agency, Tempo 4 Bldg., Washington, D. C.

SIGNAL CORPS

Commanding Officer, Signal Corps Procurement District, 2800 S. 20th St., Philadelphia 45

Chief, Laboratory Office, Contracting Division, Signal Corps Procurement District, Fort Monmouth Area, Fort Monmouth, N. J.

Chief, Photographic Center Office, Signal Corps Procurement District, 35-11 35th Ave., Long Island City 1, N. Y.

TRANSPORTATION CORPS

Procurement Division, Marietta Transportation Corps Depot, Marietta, Pa.

AIR FORCE

Director of Procurement and Industrial Planning, Air Material Command, Wright-Patterson A. F. Base, Dayton

Selling to the Navy

Current procurement. On May 19, Navy changes from competitive to competitive-and-negotiated bids. New pamphlet will bring up to date the who, what, where, and how of procurement. Meanwhile, questions may be addressed to Procurement Policy Branch, Material Division, Dept. of the Navy, Washington 25, D. C.

Mobilization planning. There is a mobilization planning officer for each Navy Bureau: Ordnance, Ships, Aeronautics, Supplies and Accounts, Yards and Docks, Medicine and Surgery, and Personnel, plus Marine Corps and Office of Naval Research (pure science). Other research handled by interested bureau.

FACTORY
MANAGEMENT AND MAINTENANCE
L. C. MORROW, EDITOR

LOOK TO YOUR QUALITY CONTROL

INDUSTRIAL management should check up on its quality control. The checking up should be done in two ways in the individual plant:

First: To find out if the quality control procedure is all it should be.

Second: To find out if the procedure is being followed carefully.

The need for a check-up on quality control has been brought to my attention by reports of poor-quality products turned out by American factories. The sources of these reports are unimpeachable.

Two of the reports are from abroad, and concern gasoline motors—a product upon which America prides itself; upon which, in fact, an important part of our reputation abroad is based. Such things as unmatched pistons, missing rings, broken parts, and maladjustments were referred to. In both cases sampling inspection by the purchasers indicated the need for 100 per cent going over, and in one case for running test.

Some Products Won't "Work"

Other reports tell of shortcomings discovered on this side of the water. They say that durable consumer goods too often won't "work" when they reach the user; that some furniture and some clothing, for example, call for additional finishing or additional sewing.

My personal experience has indicated shortcomings in automobiles, tires, furniture, clothing, printing. Add other items from your experience—industrial and personal.

Sending out of the plant goods that are not what they ought to be is inexcusable. Doing so means that quality standards are not right; or that methods of meeting standards are wrong; or that management insistence upon following right methods to maintain proper standards is lacking. Of course it can mean that all three contribute to a bad situation.

If there was one phase of production given special attention during the war, it was quality control. It was brought into the limelight by the rediscovery and development of statistical control. Also the requirements for precision in some war products were responsible for new emphasis on the tools of measurement.

Methods and tools gave rise to consideration of responsibility for quality and, hence, to the organization of personnel along definite lines of authority.

Control Must Be Independent

One thing that came out of it all was the absolute necessity for having an independent quality control department, with the man in charge reporting directly to the chief executive of the company. Production could not have the final word in quality control.

Another result was renewed understanding of the importance of cooperation between production and quality control. Without it, uninterrupted flow of products of the proper quality could not be had.

Well, those lessons of the war need not be lost. Industry has the knowledge of quality control tools and methods. It knows how to apply them. All it lacks is the willingness to do the job.

Is the quality control failure universal? An educated guess would say it is not. But I am acquainted with no statistics that could be used to put the answer in quantitative terms. Certainly enough sub-standard products are getting out of the factories to justify universal check-up and corrective measures where called for.

L. C. Morrow

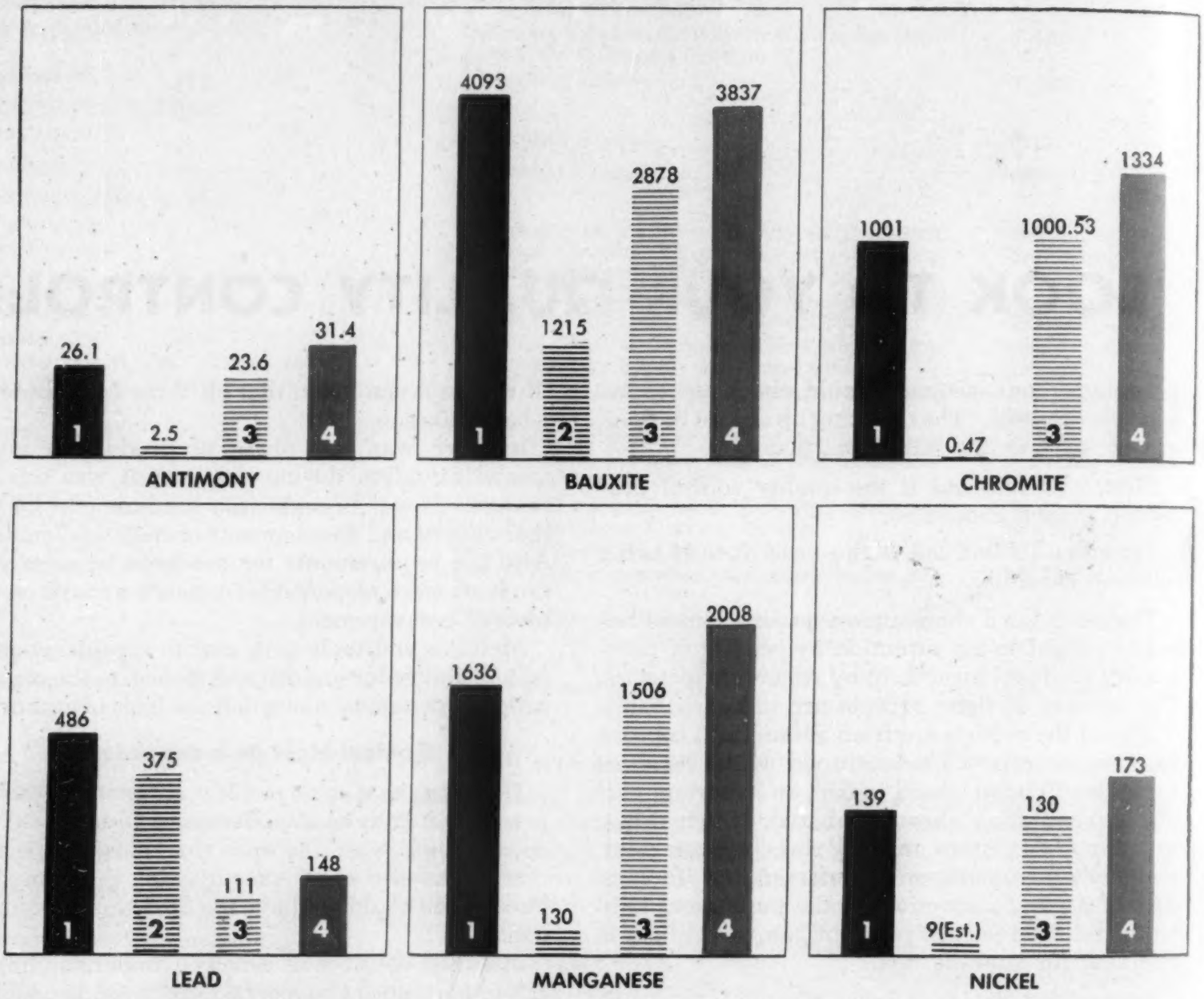
Where the United States Stands on Ten

1 Average consumption per war year (World War II)

2 Average U. S. production per peacetime year (1947)

3 Amount to be stockpiled for each year of another 4-year war to make us independent of outside sources

All amounts in thousands of tons except *cobalt* (thousands of pounds)

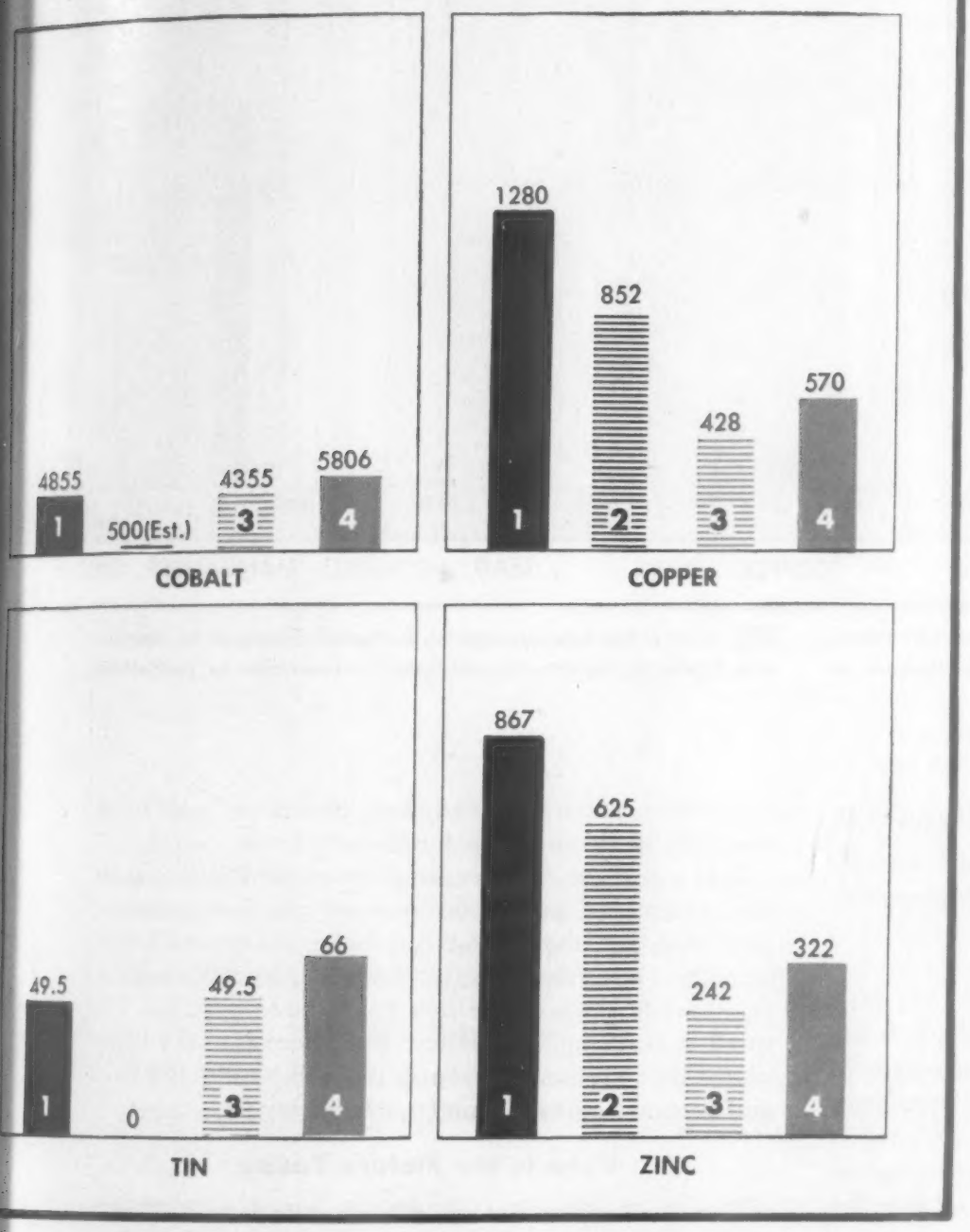


THE STOCKPILING ACT OF 1946 calls for a stockpile of 67 strategic materials to be big enough by 1951 to last through a full-scale war. So assume a four-year war and three years left to get ready. Then it becomes a simple exercise in arithmetic to find out where we stand at the present time. To illustrate, FACTORY has chosen ten materials on which it is well known that the stockpiling program lags. Each chart shows (1) an average war year's requirement. Subtract (2) average annual current production to get (3) what

BUILD THE STOCKPILE NOW FOR NATIONAL SECURITY

Strategic Materials

4 What U.S. must stockpile per year for the next three years to be ready by 1951 for another 4-year war



we need for each year of war. Multiply by four to get the requirement for a four-year war and divide by three to get (4) the minimum amount we ought to stockpile in each of the three years that are left. See page 54 for complete list of materials to be stockpiled

STOCKPILING STATUS

* * *

Goal: Enough of 67 strategic materials for a major war

* * *

Time limit: Five years (1946-51)

* * *

Time left: Three years

* * *

Cost: Congress estimates $1,800,000,000

* * *

Cost at today's prices: $3,100,000,000

* * *

Spent to date: $275,000,000

* * *

Progress: Except for a few materials, program is far behind schedule

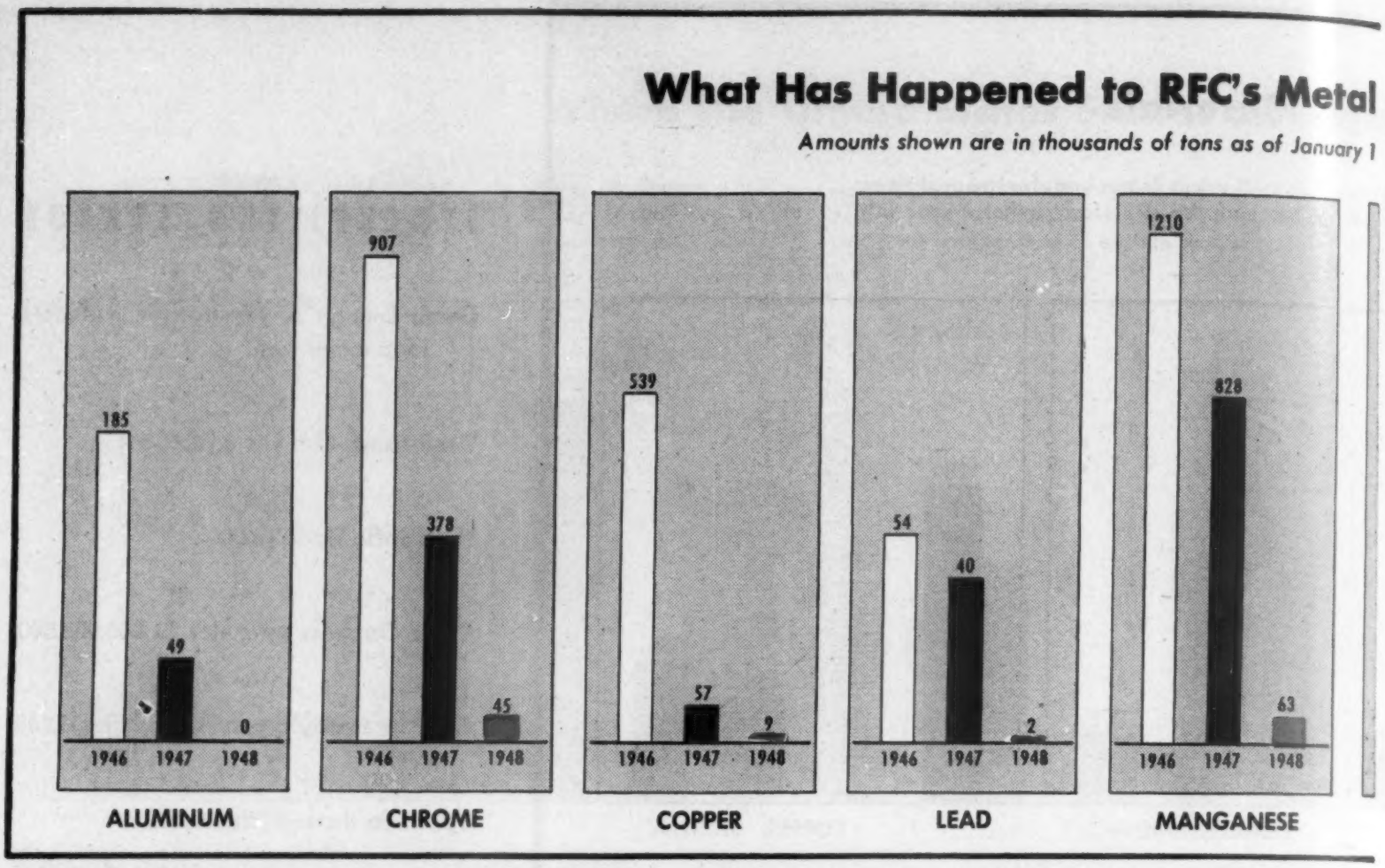
* * *

Cause: Mainly penny-pinching

* * *

Remedy: More money, policy changes, sharing of scarce items by industry, a better-informed public

Rumania. Czechoslovakia. Finland. Who's next? Events in Eastern Europe prove that Congress did exactly right in 1946 when it planned a stockpile of 67 strategic materials—to be big enough by 1951 to support a full-scale war. ~ One-third of the time has now elapsed. The size of the stockpile can't be told — for security reasons. But it is altogether too small. It becomes plainer every day that little progress is being made —for a number of reasons. ~ FACTORY examines the reasons in this timely article,



WHAT HAPPENED to government stores of eight important metals after war ended, is shown in this chart. Office of Metals Reserve, an RFC agency, was biggest single U. S. stockpile, pumped its reserves into American industry to help speed reconversion to peacetime

and proposes seven major policy changes it believes should be made this year — if America is to have the stockpile that plain common sense demands

AMERICA'S defense stockpile is in bad shape. It is the poor relation of U. S. national defense—poor in funds and poor in the critical materials this country would depend on in time of war.

With more than a third of the 5-year stockpiling period (1946-1951) already past, only a handful of the 67 critical materials have been purchased and stored away at the scheduled rate. The vast majority of the strategic metals, chemicals, and other substances on the stockpile list are woefully short.

In a number of important materials, observers agree, United States stocks held privately and by the government are now at a lower level than in 1941.

In view of the fact that the value of domestic metal produced in the United States last year was a record $3 billion—up 65 per cent from 1946—this looks like a paradox.

The facts are, however, that world production of some strategic materials is still recovering from the disruption of war. In addition, American industry is currently consuming practically every kind of material at record rates.

Result: The government, hewing to the policy set by Congress, has refrained from competing with industry for scarce materials, and has therefore had little opportunity to purchase for the stockpile.

This is not the only reason defense stockpiles are so low. Although Congress decided a stockpile was necessary and that the nation had better have one large enough to last through a full-scale war by 1951, appropriations for two of the five years have been far too small to carry out this policy. And there is every likelihood that the new appropriation will be like the first and second—certainly not much bigger.

Here Is the Picture Today

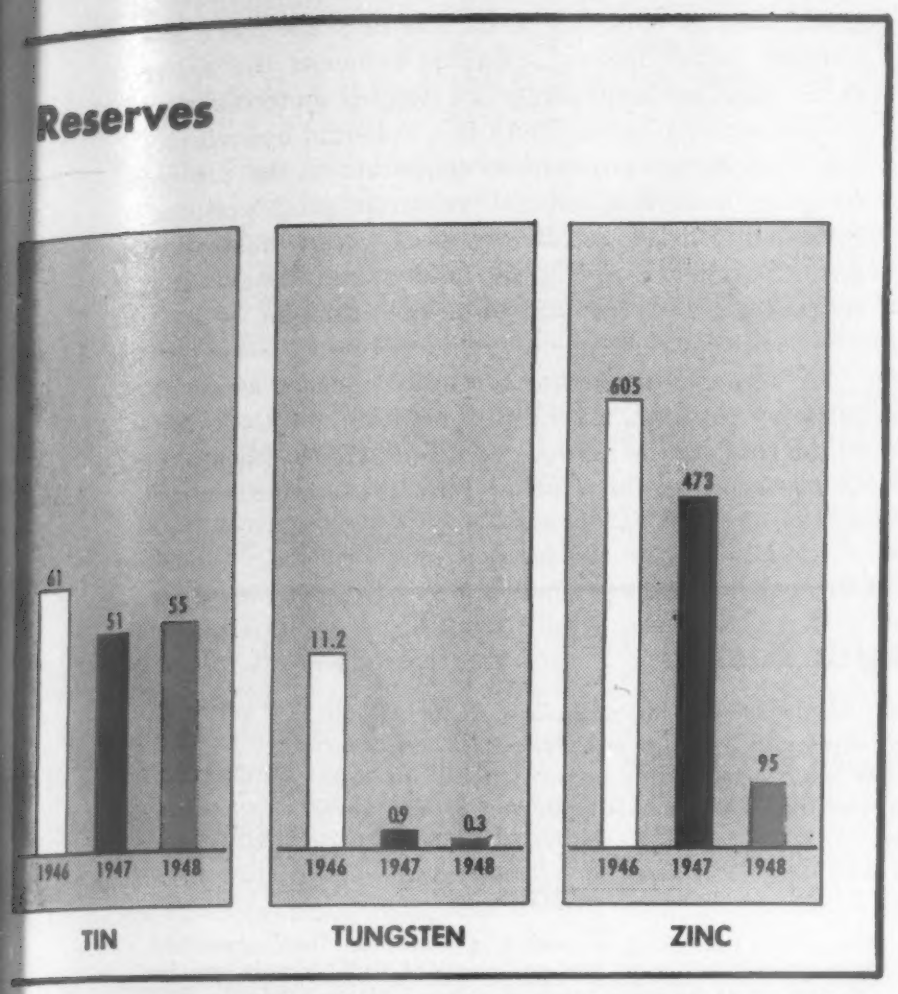
The Stockpiling Act of 1946 (Public Law 520, 79th Congress) set a ceiling of $360 million a year for five years with which to buy materials for the stockpile. That adds up to $1.8 billion.

Since then, prices of most items have risen sharply. The Munitions Board, which administers the Act, estimates that today the same stockpile will cost $3.1 billion—or $550 million annually for five years. (The Board has inherited about $400 million worth of critical materials from other government agencies.)

Ignoring these statistics and its own earlier conclusions, Congress has granted the following stockpile funds which are hardly more than pittances, in relation to the size of the job:

Fiscal 1947	$100,000,000
Fiscal 1948	175,000,000
Fiscal 1949 (requested)	285,000,000*

* Likely to be cut substantially



economy. Defense stockpile got substantial amounts of tungsten from OMR, but little else. Industry's needs continue to get priority

Nor does the story end there. Congress also limited contracts for future deliveries to one year. Yet mines take 2 to 5 years to get into production. And because metals make up 90 per cent of the stockpile, this policy has consistently hampered the Munitions Board in its administration of the Stockpiling Act.

Why the Program Lags

There are, in brief, three main reasons why the defense stockpile is so far behind schedule:

1. Congressional penny-pinching.

2. Stockpilers may buy only what U. S. industry does not want of scarce materials—and these amounts are very small.

3. One-year contracts for future deliveries hamstring government efforts to stimulate long-term mining production.

In an era of uneasy peace, this is a ridiculous and dismaying situation. It has become a commonplace to remark that any future war will come with appalling swiftness and suddenness, that America must be able to mobilize its vast potential in record time or risk extermination. For all their banality, nevertheless, these statements remain true. Modern war demands industrial strength. American industry can perform only if the required materials are available. And while the United States is blessed beyond most nations with the essential resources, without the stockpile items—tin, industrial diamonds, chromite, and a host of others—industry would be greatly hampered. The stockpile of strategic materials forms an essential link in the chain of national defense.

What to Do About It

If America is to have an adequate defense stockpile, seven major policy changes must be made this year:

*1. **Congress must loosen the pursestrings.*** Appropriations in the order of $700 million to $1 billion annually for 1949, 1950, and 1951 are required, if the Munitions Board "minimum stockpile" is to be purchased by the 1951 deadline.

*2. **The stockpile objective must be substantially raised.*** The present size of the stockpile—around $3 billion—is acknowledged to meet only the bare war essentials. Experts agree that a third war—at the present pace of technological advancement—may well make demands far larger than even the colossal drain of the last conflict. Wars cost more each generation. Competent authorities recommend raising the stockpile goal to at least $5 billion, perhaps higher.

*3. **A long-range program is required.*** Authorities emphasize that stockpiling for defense is a long-range proposition. The 1951 objective can be considered, in their view, a goal for the immediate future. No less important, however, is the story told in the statistics of U. S. resources. Their rate of development—and attrition—has been astonishing in the period since World War I. On the other hand, the rate of new discoveries has dropped off sharply. If the next generation has to fight a war, it is the opinion of several well-informed sources that U. S. production of many metals will have fallen off substantially. A 20-year stockpiling program, as a long-range hedge against depletion of national resources, makes hard sense. Despite an over-all cost of $10 billion or more, the expense of such an investment would be cheap when viewed from the standpoint of future national security.

*4. **Congress must give the Munitions Board enough authority to get the job done right.*** First, stockpilers should be permitted to sign contracts for delivery of required materials three to five years from now. By furnishing an assured market at a fair price, the Munitions Board would be able to stimulate the extra production at home and abroad that would bring out the scarce items it so badly needs.

Second, some competition with industry for stockpile materials should be allowed. Since the war ended in 1945, industry has been given a free hand—and has drained off large stocks of materials held by the Office of Metals Reserve—to help speed up the reconversion from war to peace. That policy has now served out its usefulness. It is time the defense stockpile got a slice of the loaf, not just the extra crumbs.

*5. **Tax incentives must be offered to bring out venture capital.*** At the present time, the mining industry is hamstrung by unfair tax laws in developing new resources and exploring possibilities. Only about one

new mine in ten proves to be successful. Investors who advanced the money to open the nine "duds" are, however, not permitted to recoup their losses—if this can be done—through profits from the tenth. Result: Venture mining capital is difficult to find, and the rate of discoveries and developments is low. Congress should amend these tax laws to remove this burden from the mining industry.

*6. **Research to utilize U. S. marginal resources must be stimulated.*** If techniques can be developed to make economic use of America's marginal deposits, her total national resources will be vastly increased. Research to develop methods to extract metals from low-grade ores on a paying basis will be come more important as the mining industry exhausts the richer lodes. Such research cannot be stepped up too soon, or on too broad a basis. There is a splendid opportunity here for the government to cooperate in the present company and institutional research programs, and furnish the drive and money that would make them pay off earlier. How big this field is, and the extent of its potentialities, has still to be determined.

*7. **There is altogether too much secrecy about defense stockpiling.*** At the present time, only one copy of the confidential annual report on defense stockpiling is returned to the House. Few representatives are

The Stockpile List

The Munitions Board lists 67* basic strategic and critical materials for stockpiling. To get on the list, each item must fulfill "essential uses in a war emergency" and its procurement "in adequate quantities, quality, and time" must be "sufficiently uncertain, for any reason, to require prior provision for the supply thereof." These 67 items, including their various types and grades, have been classified according to the criteria listed below.

GROUP "A"

(Items "for which stockpiling is deemed the only satisfactory means of insuring an adequate supply for a future emergency.")

- Agar
- Amosite (S. African)
- Antimony
- Asbestos (Rhodesian chrysotile)
- Bauxite
- Beryl
- Bismuth
- Cadmium
- Castor oil
- Celestite
- Chromite (metallurgical)
- Chromite (refractory Rhodesian)
- Cobalt
- Cocoanut oil
- Columbite
- Copper
- Cordage fibers (manila)
- Cordage fibers (sisal)
- Corundum
- Diamonds (industrial)
- Emetine
- Graphite (amorphous lump)
- Graphite (flake)
- Hyoscine
- Iodine
- Jewel bearings (instrument rings)
- Sapphire vees
- Watch rings
- Kyanite (Indian)
- Lead
- Manganese ore (battery grade)
- Manganese ore (metallurgical grade)
- Mercury
- Mica (Muscovite block and film)
- Mica (Muscovite splittings)
- Mica (phlogopite splittings)
- Monazite
- Nickel
- Opium (contained morphine)
- Palm oil
- Pepper
- Iridium
- Platinum
- Pyrethrum (20% extract)
- Quartz crystals
- Quebracho
- Quinidine
- Quinine
- Rapeseed oil
- Rubber (crude natural)
- Rubber (natural latex)
- Rutile
- Sapphires and rubies
- Shellac
- Sperm oil
- Talc (steatite block or lava)
- Tantalite
- Tin
- Tung oil
- Tungsten
- Vanadium
- Zinc
- Zirconium ores (baddeleyite)
- Zircon

GROUP "B"

(Items "the stockpiling of which is practicable." Their acquisition is recommended, but "the adequacy of (U.S.) supply can be insured either by stimulation of existing North American production or by partial or complete use of substitutes.")

- Aluminum ingot
- Calcite (optical)
- Chalk (English)
- Chromite ore (chemical grade)
- Cryolite (natural)
- Diamond dies
- Emery
- Fluorspar (acid grade)
- Fluorspar (metallurgical grade)
- Graphite (crystaline flakes)
- Indium (metallic)
- Jewel bearings and other instrument jewels
- Magnesium ingot
- Mica (Muscovite block)
- Mica (phlogopite block amber)
- Molybdenum
- Osmium
- Other watch jewels
- Platinum
- Rhodium
- Ruthenium
- Selenium
- Talc (steatite ground)
- Wool

GROUP "C"

(Items "not now recommended for permanent stockpiling because (the) difficulties of storage are sufficient to outweigh the advantages to be gained . . .")

- Asbestos (Canadian chrysotile)
- Bristles (pig and hog)
- Burlap (jute)
- Cordage fibers (hemp, American henequen)
- Cordage fibers (jute)
- Cork
- Glass (optical)
- Iron ore
- Kapok
- Leather (cattle hides)
- Calf and kip skins
- Loofa sponges
- Lumber (balsa)
- Lumber (mahogany)
- Petroleum and petroleum products
- Radium
- Scrap (iron and steel)
- Sesame oil
- Uranium

*Counting the various types and grades, there are 106 items on the Munitions Board list.

Can the European Relief Plan Help Stockpiling?

Can the "Marshall Plan" countries help build America's defense stockpile by repaying loans in strategic materials? It is a popular idea, in and out of Congress. Investigation, however, shows up the idea as impractical on three counts.

First, the 16 countries need all the materials they can produce to sustain their own economies.

Second, they have few strategic materials, even under normal conditions, which are plentiful enough to be exported in large quantities. There is, for example, only one large copper mine in Western Europe, at Mansfeld, Germany. U.S. copper experts expect several years to pass before even the national demands on this mine can be satisfied.

Third, where potential "extra" production exists, it will take years to develop. The American defense stockpile needs building now and in the immediate future.

Therefore authorities see little help in this quarter, at least for some years to come. Certain of Europe's colonial possessions and China and Korea offer hope, if the U.S. wants to go in and develop such resources as tin and tungsten. In addition to the difficulties of operating under the unsettled conditions that prevail in much of China and Korea today, there is the vulnerability of the supply lines to consider. The money and effort it would take to exploit such resources, it is felt, might better be spent elsewhere.

To a number of students of the problem, "elsewhere" means Africa. A treasure house of strategic materials, that continent possesses the additional virtue of being controlled by powers friendly to the U.S. Given time and money, there are tremendous resources to tap.

Take chromite. The United States produces only a small fraction of the amount it requires for steel alloys. Today, at one Rhodesian mine, there are 500,000 tons of chromite ore piled up at the pithead, awaiting shipment. It was mined during the war and cannot be moved because the 175-mile railroad between the mine and the outside world has completely broken down. It must be rebuilt before the rich ore can be exported.

In a word, it will take more than ERP and the existing stockpile regulations to build the defense stockpile up big enough, soon enough.

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familiar with its contents. The public knows nothing at all, beyond the over-all sum expended and the items listed for purchase. The Munitions Board defends this policy as being necessary to national security, and to prevent speculation. However, production and consumption figures for almost all the materials are published at set intervals, so it is possible to figure with some accuracy how much has been laid away by the government during a given period. FACTORY found that officials in the various metals industries knew with precision the stockpile's current position regarding their own products. It would be naive to think that foreign intelligence forces are not doing the same figuring.

The armed forces, with as much reason for secrecy, are more open about their activities. Appropriations for battleships, planes, etc.—their general specifications and approximate delivery dates—are spread on the public record in the budget. Congress knows what is going on. But this cannot be said with regard to defense stockpiling. The reason is simple; only one report goes to the House; only one to the Senate. Both being confidential, neither is debated in public session. Congress and the public are left largely in the dark.

Nor is speculation curbed by keeping the stockpile confidential. It is obvious that no large customer can step into a market and buy in quantity without the trade being aware of the move. Making public what has been purchased during the past year is not going to affect speculation one way or another. The Munition Board's privilege of buying *what* it chooses *when* it chooses is the essential point, and would be in no way affected by such a policy.

Less secrecy about stockpiling would serve two good purposes. To begin with, the taxpayer has the right to know how so important a security measure is being carried out. If it were widely known today that the defense stockpile is as far behind schedule as it actually is, there would be plenty of acid comment and Congress would take action.

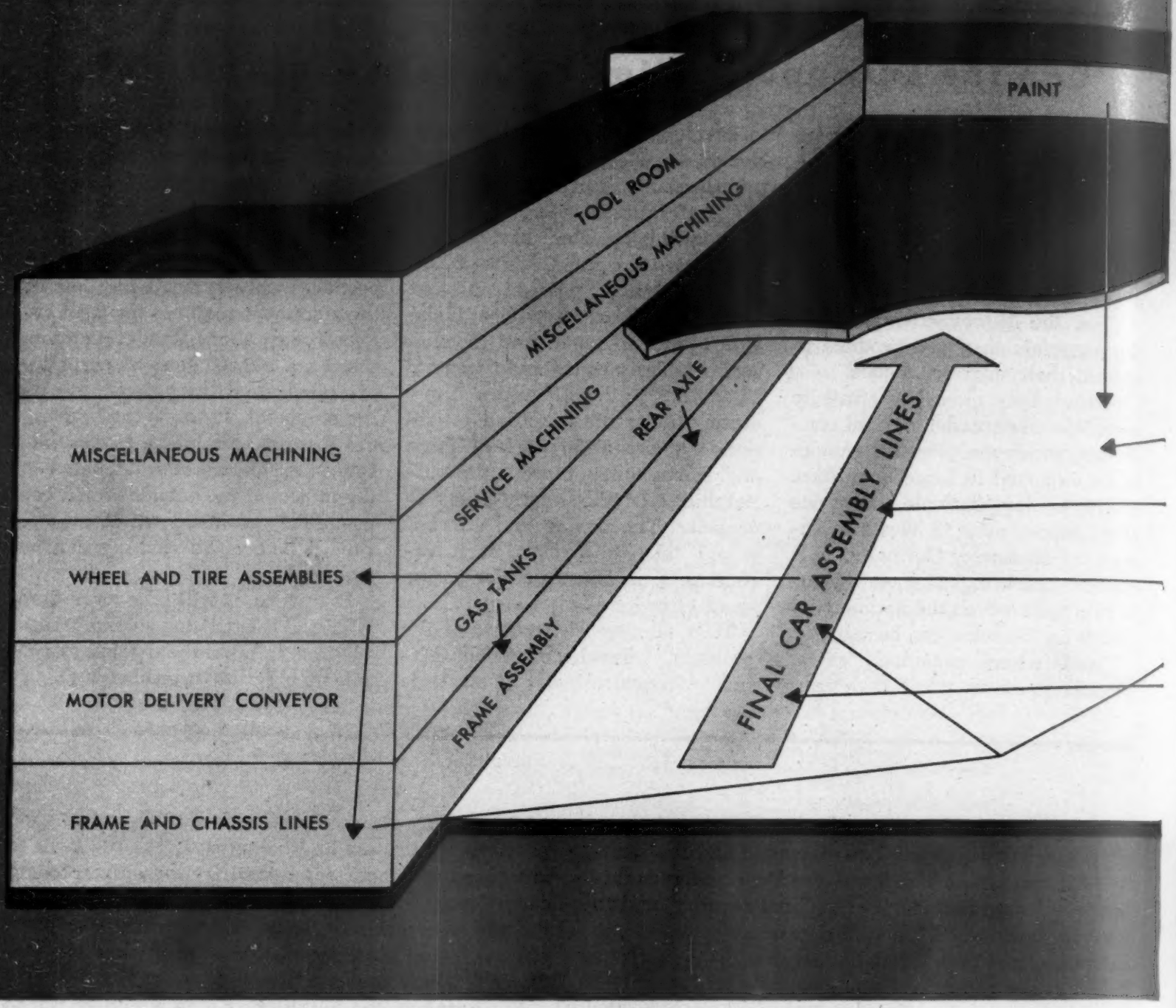
Furthermore, the Munitions Board would be put to the test to show that its stewardship had been as anxious and alert as it ought to be.

To sum up: The stockpiling program is far behind schedule and exists on a starvation diet. Sufficient quantities of the strategic materials this nation needs in case of war will not be on hand by 1951—not at the present rate of acquisition, not even if the present rate were doubled.

Drastic action is required—if the U. S. defense stockpile is to come from behind and reach the objective set by Congress in 1946. Congress must grant much larger funds. It must also make broad changes in policy and tax laws. Industry must accept the principle of sharing certain scarce materials with the stockpile. The Munitions Board (and the National Security Resources Board, which now shares responsibility in this field) must push the program more vigorously.

Finally, there must be less secrecy. A stockpile is a deterrent to war, not an invitation. More important than that, public knowledge, interest, and backing are essential to the success of any such large and vital undertaking.

America cannot afford to fail. She must take stock of her stockpile.



SCHEMATIC DRAWING OF PACKARD CAR ASSEMBLY SHOWS FLOW OF COMPONENTS FROM BALCONIES TO THE POINTS OF USE

SYNCHRONIZING SUBASSEMBLIES

No temporary storages. Components "dropped in" where needed. Space saved. Production efficiency increased

FLOYD J. BIRD • FACTORY MANAGER, PACKARD MOTOR CAR COMPANY, DETROIT

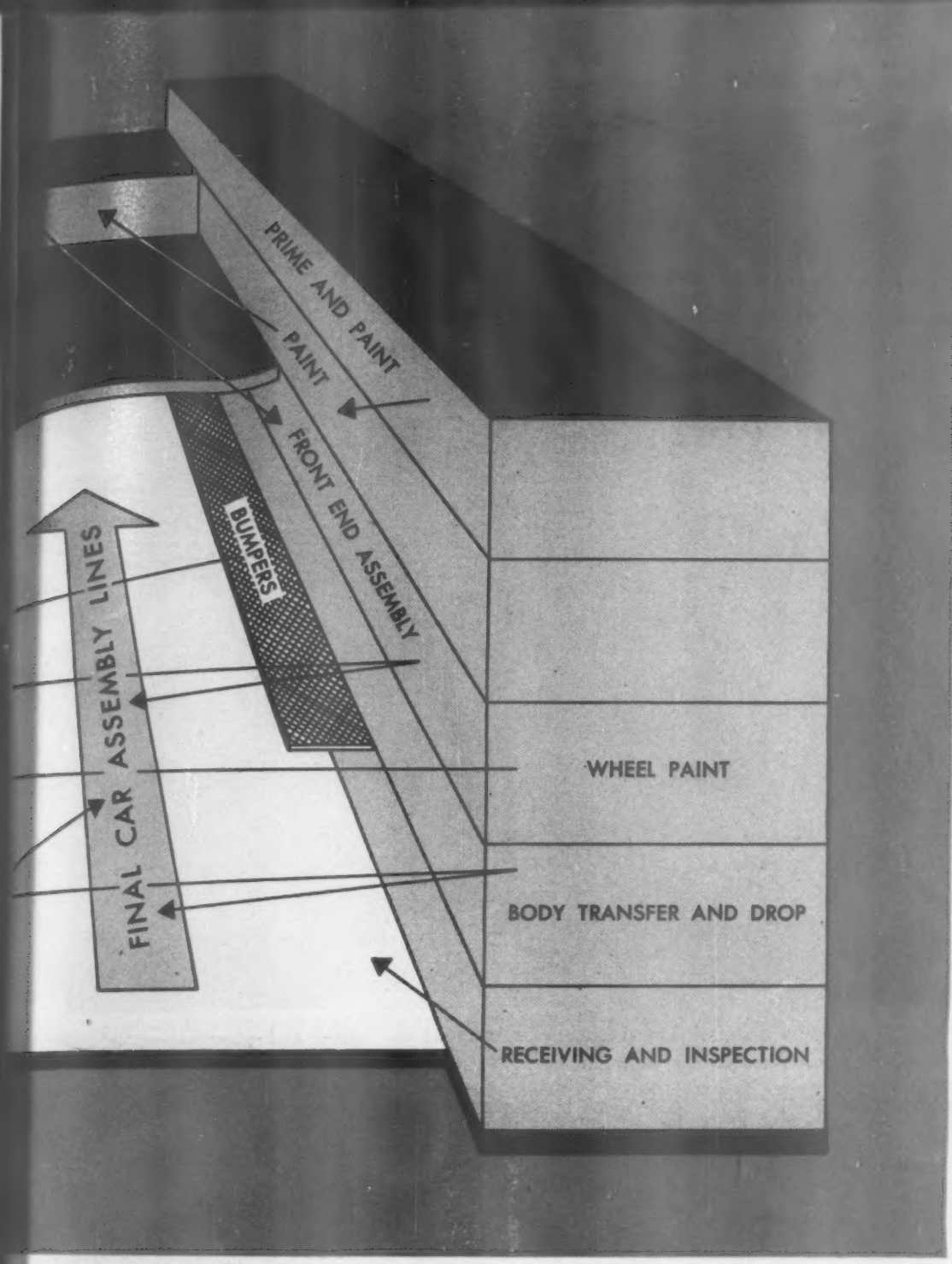
DOUBLE the production in the same plant area. Productive efficiencies up 25 per cent. Improved product quality. Handling costs down 30 per cent. These are but a few of the benefits being realized at Packard through application of straight-line flow principles to plant layout.

All operations have been "streamlined," with unnecessary work eliminated. Plant layout improvements have been made from the receiving dock, through manufacturing, to the final shipment of the finished automobile.

Receiving. Before, there was only one main receiving station. Now, materials are received through many substations, close to their point of ultimate use. This, alone, has cut transporting distance and saved time.

All incoming materials are inspected in the receiving rooms before being released to production. This eliminates the possibility of unacceptable parts getting into production. Such parts could, and often did, cause production hold-ups—but no longer.

Material flow. The layout was so planned as to *force* materials to flow in straight lines from receiving to their "point-of-use." All back-



THEREBY ELIMINATING ALL TEMPORARY STORAGES AT THE FINAL ASSEMBLY LINE

TO MAIN LINE NEEDS

tracking was carefully studied and minimized.

Assembly lines. Both component and main assembly lines were stretched out in length. The purpose was to permit storage of materials right in the line. Before, materials were placed on the side of aisleways as close as possible to their point of use. This required an excessive amount of handling, and was costly.

The new system guarantees the worker an ample supply of parts at all times. It eliminates waiting time for materials. And it "outlaws" the temporary storage required before. Materials handling gangs operate at night to replenish line supplies for the next day's production. Result: Assembly lines are operating more efficiently; floor space is saved; damage to materials is minimized; handling time and costs have been reduced.

Body parts. Miscellaneous body parts, such as steering wheels, trim hardware, and other small accessories, are now placed in the body while it is on the body line, and are carried there until needed for assembly on the final line. Before, parts like these were stored on the final lines near their point of installation. Utilizing the interior space of the body for storage not only saves floor space, but also prevents damage to the parts.

Balconies. All component assemblies (front ends, seats, bumpers, and the like) are assembled on a series of balconies running parallel to the final car lines. This makes it possible to drop these components (via conveyor) to the final line directly at their point of assembly to the car. All former temporary storage space along the main lines for these parts has been eliminated. Speeds of subsidiary conveyor lines are balanced with the final line so that the required number of components are delivered as cars come by. This arrangement has saved space, eliminated damage to components, and increased the efficiency of production operations.

Downtime during model change-over seasons has always been a problem. Often as much as 3 months were required to make the necessary alterations in production to build a new model. This problem has now been largely solved.

During the recent change-over from 1947 to 1948 models not one day's production was lost. No employees were sent home. This was accomplished with the "twin assembly lines" in the final car division. As 1947 models rolled off the one line, 1948's were starting to come off another.

Two final car lines, running parallel to each other, make possible doubled production capacity. Lack of critical materials has prevented Packard from fully utilizing this new production set-up, but many benefits are being realized. Installation of the second final car line was made possible through the savings in floor space previously mentioned.

Application of straight-line flow principles to plant layout and *forcing* materials to move has produced many benefits. Handling costs are going down. Distance of moving materials is considerably reduced. Improved storage facilities are provided. Plant appearance is better. Crowding of materials and workers has been eliminated. And productive efficiencies are going up.

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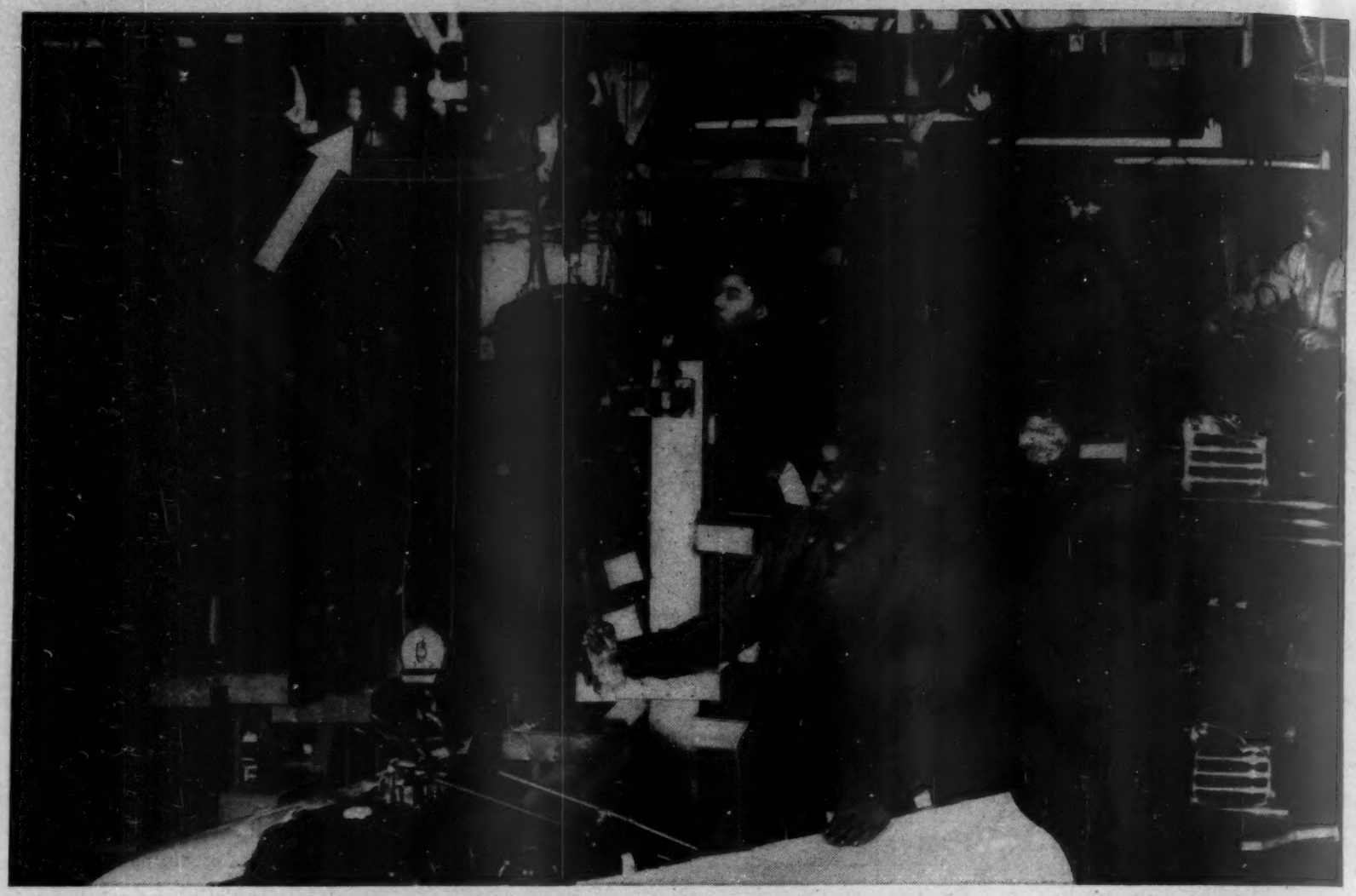
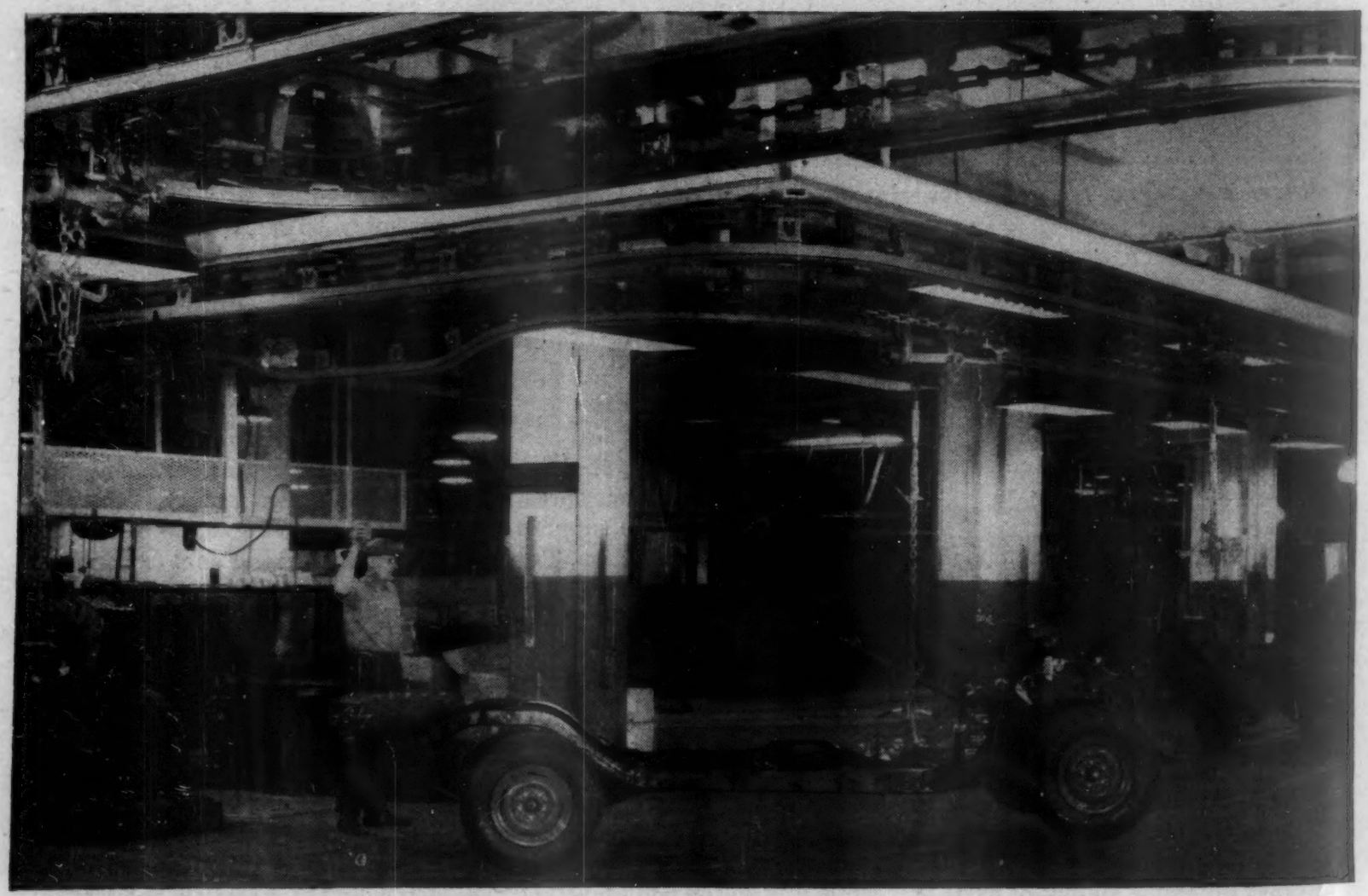


FINISHED ASSEMBLIES are transferred to conveyor (arrow) which moves them to point of use. Here is one of several balcony lines where components are built to be "dropped in" where and when needed in final car assembly. Complete front ends are

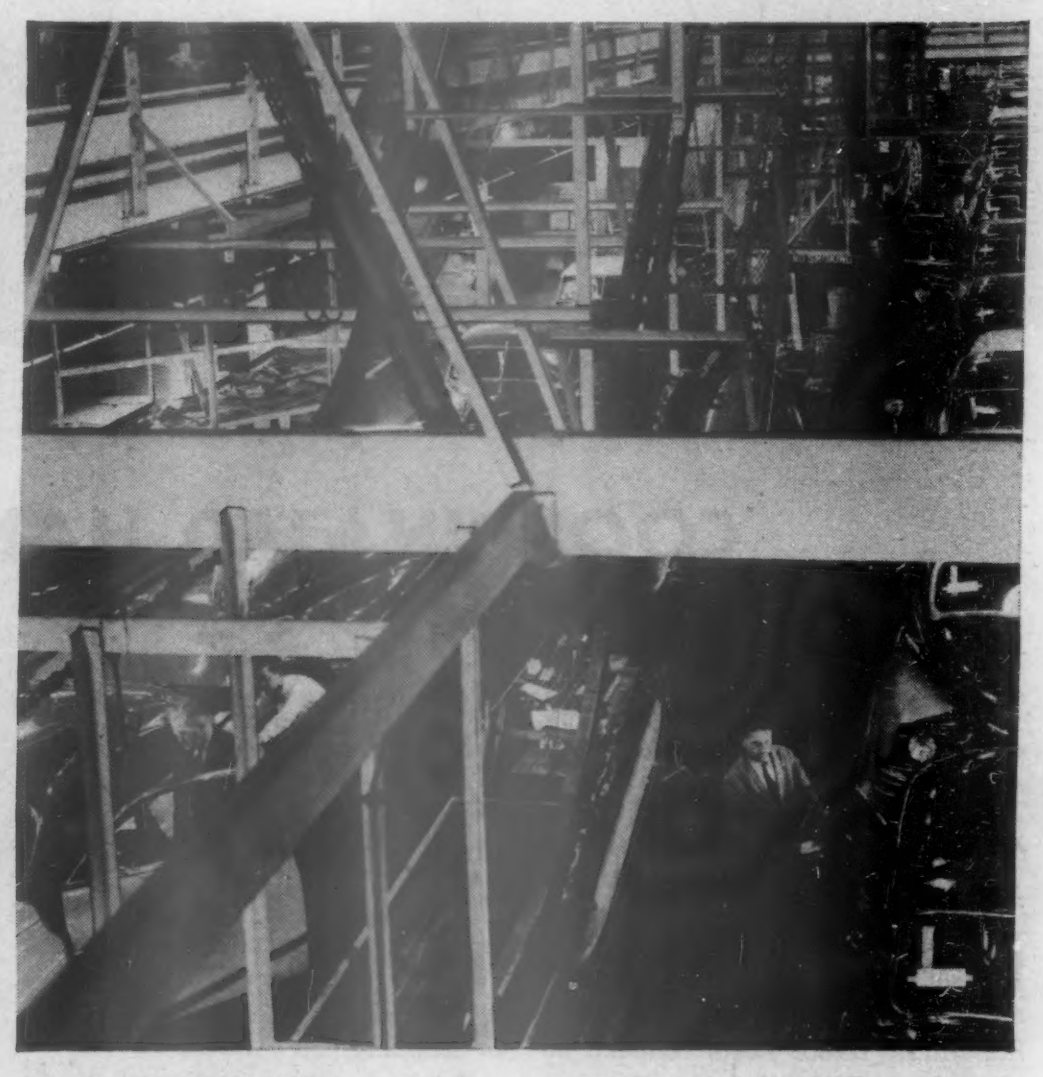


FRAME AND CHASSIS are assembled complete and thereupon moved to beginning of main line. Workers used to push chassis. Now special overhead chain conveyor does work. Chain is hooked to frame as chassis comes off line. Front end is picked

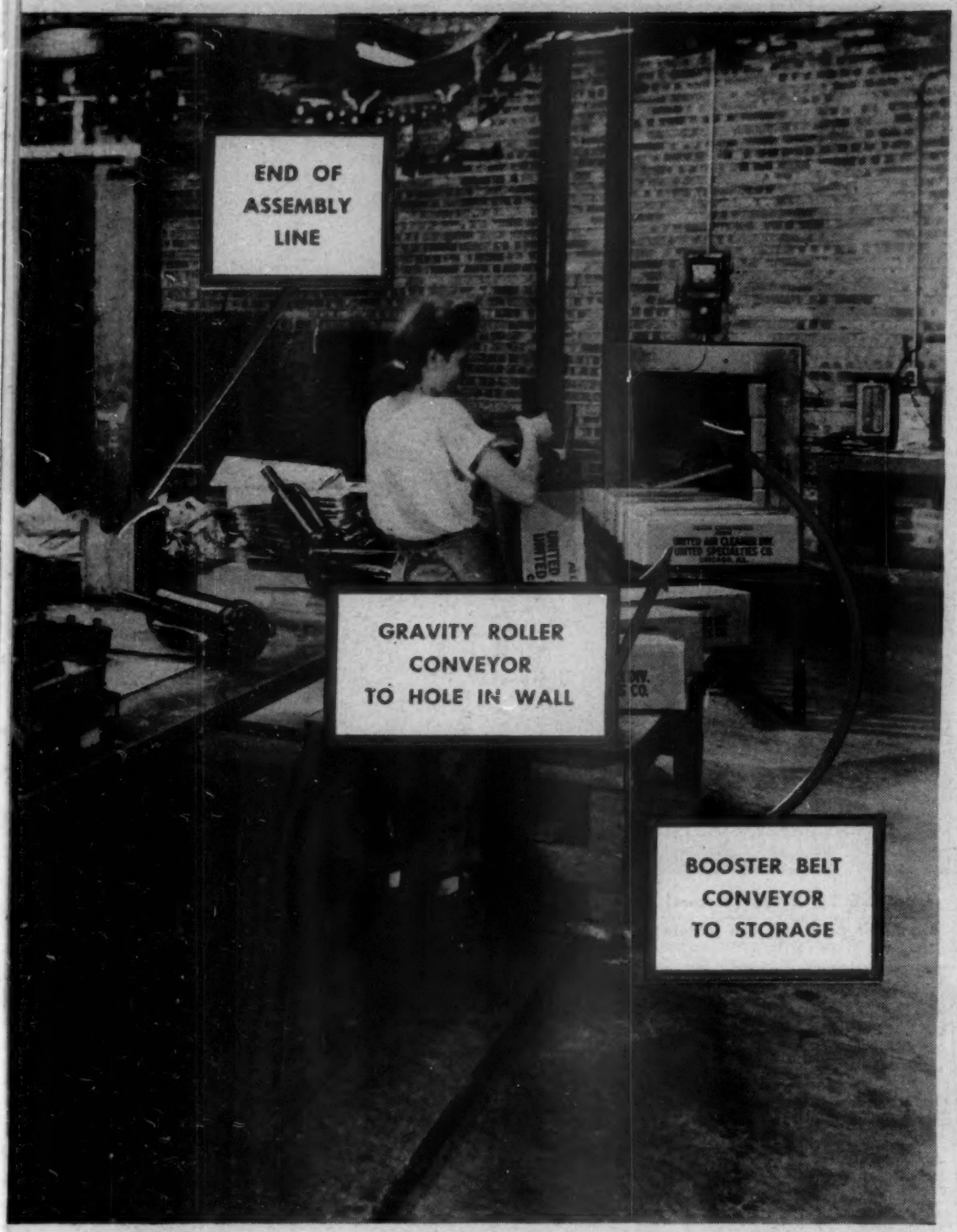
assembled on merry-go-round (four-wheeled trucks on track)

ACCESS TO BINS (arrows) in pits under final lines is from lower level; parts needed to stock pit positions are lowered through floor opening, distributed by truck

up and chassis is towed around curve and delivered to final assembly



FINAL ASSEMBLY LINES are fed by component lines in balconies (see schematic layout on pages 56 and 57). Delivery to point of use has eliminated storages



ASSEMBLY TO STORAGE. BY ROLLER CONVEYOR TO BOOSTER, THEN THROUGH THE WALL

FROM STORAGE TO SHIPPING. CARTONS . . .

COORDINATED HANDLING CUTS

Conveyors from assembly lines to storage and from storage to shipping banished manual handling and rehandling

ALLEN VANDER MEULIN • VICE-PRESIDENT IN CHARGE OF MANUFACTURING, UNITED SPECIALTIES COMPANY, CHICAGO

INCREASED efficiency and lowered costs. Improved housekeeping and plant appearance. No manual handling. Labor costs reduced 60 per cent. All this and more has been accomplished at United by the installation of mechanical methods of conveying packaged air cleaners from assembly, through storage, and to shipping.

Formerly the various types of air cleaners made by this company were placed on hand trucks located at the end of each assembly line. Loaded trucks were pushed to storage or to the shipping dock.

Too Much Hand Loading

If the trucks went to storage, they were unloaded and the cartons were stacked by hand. When it came time to ship the cartons, they were again loaded on trucks, pushed to the shipping dock, and put into the waiting truck trailers or freight cars.

. . . RIDE POWER-DRIVEN BELT CONVEYOR THAT RUNS ENTIRE LENGTH OF SHOP. SHIPPING INFORMATION STENCILED EN ROUTE

LABOR COSTS 60 PER CENT

Wide aisles were required for the trucks, and no definite flow lines were maintained.

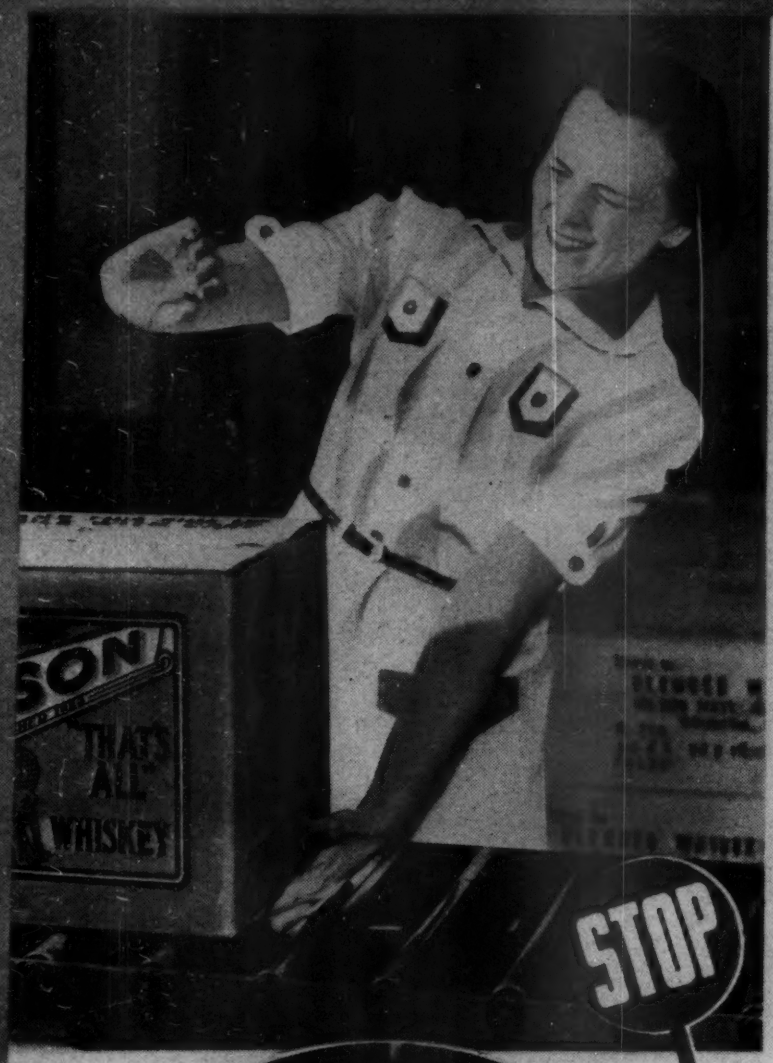
As production schedules grew, it began to look as if the plant would have to be expanded. But industrial engineers assigned to the problem came up with a plan to eliminate the manual handling and use mechanical methods to transfer the product from assembly lines to storage and to shipping.

In the new set-up, assembly lines feed directly to the storage room wall. Four holes, one for each assembly line, were knocked through the wall. Gravity roller sections are located at the end of each assembly line. Cartoned cleaners feed down the lines to a power-driven-belt booster conveyor, which carries them to the storage room. Thus each type of air cleaner is delivered to its own point of storage.

When ready for shipment the cartons are slipped onto a gravity roller conveyor section which carries them to the power-driven reversible belt conveyor that runs the entire length of the storage room to the shipping dock. From this point on, the carton is entirely on its own. It feeds up an incline toward the end of the shipping room, where an operator is located to stencil shipping information. Then the carton slides off on a steel chute and into the truck or freight car by way of a portable roller conveyor section.

Conveyors do your heavy work

Conveyors are harmless unless you toy with them. Never take a short cut at the risk of your safety. Include safety as a regular part of your daily thoughts.



WRONG WAY (STOP), RIGHT WAY (GO), TO TIER BARRELS. "IF IN DOUBT," SAYS SEAGRAM BOOKLET, "CONSULT YOUR FOREMAN"

TYPICAL PAIR OF STOP-GO PHOTOGRAPHS DEMONSTRATE NEED TO WEAR SPECIAL SAFETY CLOTHING WHEN HANDLING CHEMICALS

SAFETY—GO AND NO-GO

MYRON E. SANDERS • CENTRAL OFFICE SAFETY DIRECTOR, JOSEPH E. SEAGRAM & SONS, INC., LOUISVILLE

It's "stop" and "go" in safety at Seagram's. The red and green traffic signs so familiar to all of us are used effectively in a 40-page booklet called "Go Ahead With Safety." Every new employee gets a copy.

Purpose is to impress upon the employee that (1) management is 100 per cent back of the safety program; (2) he himself should take an active interest in his own safety; (3) there are right and wrong ways to do each job.

Shown opposite is a sample page from the booklet. It warns workers not to monkey with conveyors. Directly above, on this page, are two typical pairs of photographs. They demonstrate (1) that barrel accidents don't always "just happen"; (2) how to "protect yourself from chemicals." (Black go signs here are actually green in the booklet.) On many of the pages, there is a "first aid note" identified by the customary red cross.

Emphasis throughout is on getting a simple message across quickly. The well-posed photographs, the distinctive traffic sign, and the brief safety warning are all combined to achieve this objective with unusual effectiveness.

MODERNIZATION HELPS OUTPUT IN A BOTTLENECK INDUSTRY

Better working conditions mean higher-type employees. With improved tools and machinery, and with the same amount of physical effort, man-hours per ton are reduced

MECHANIZATION and planned control are carried as far as is practical in the new high-alloy foundry of the Electro-Alloys Division of the American Brake Shoe Company at Elyria, Ohio. Good light, proper ventilation, and excellent employee facilities all contribute to making the foundry a more attractive place to work.

With higher-type employees than are normally attracted to foundry work, and with improved tools and machinery, man-hours per ton of castings are expected to be materially reduced with the same amount of physical effort.

This foundry, producing miscellaneous castings of all sizes and shapes, is laid out for the most efficient flow of materials and finished products, thereby reducing to a minimum handling costs in all stages of production.

On these two pages and the one that follows are shown some of the ways in which mechanized handling is being used to help achieve these results in this foundry.

1. Flat car moves big cores into and out of baking oven. Following core-making, large cores are transferred to the main floor by overhead crane, where they are placed on a flat-bottom car. The car is then shunted into a core baking furnace. Note that the furnace shown discharges or loads from either of two foundry bays.

Small cores are transferred to baking ovens on special racks by a hand lift truck. Drying of these cores is provided for by two component rack-type ovens.

*2. **Power truck dumps sand in floor bin that supplies muller.*** Dried and washed silica sand is brought into the foundry in boxcars. Ordinarily, sand is unloaded from the boxcars to adjacent storage bins by using a small, portable belt conveyor. As sand is needed, a power truck picks it up and dumps it into a floor bin which supplies the muller above. This floor bin is so arranged, however, that sand may be unloaded from the boxcar right into bin.

From this point, a bucket elevator lifts the sand to a storage bin above the same muller. The oscillating conveyors from the shake-outs also discharge onto this elevator (after passing under a magnetic pulley, which removes all metal from the returning sand).

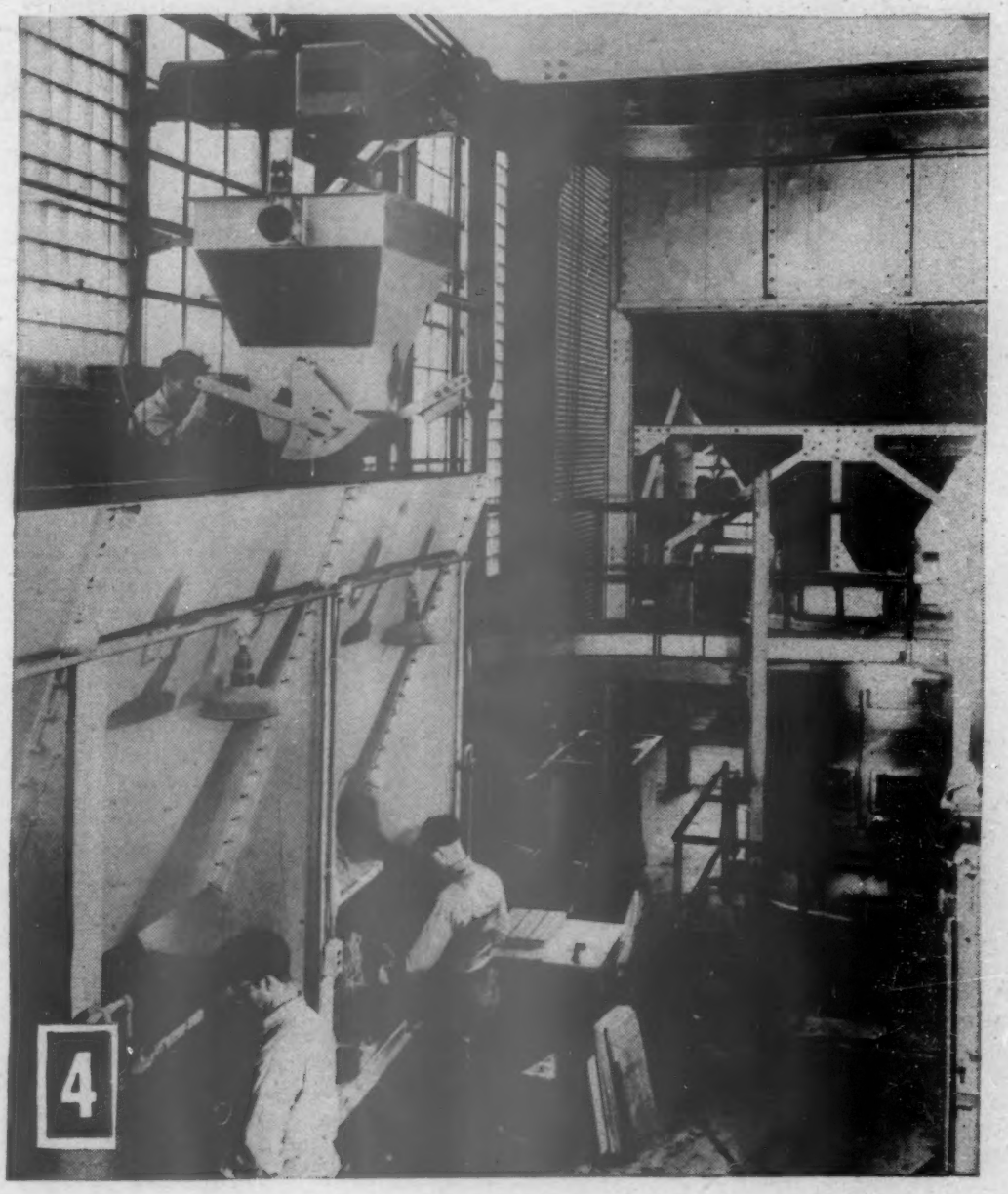
*3. **Conveyor belt moves mulled sand to molding machines.*** In the muller, sand is mixed with bonding agents. After the operation is completed, the conditioned sand is discharged onto either of two 24-in.-wide belt conveyors running 30 feet above the production floor. As the sand moves along on the belt, deflectors or scrapers direct it off the belt into bins located over the various molding machines on the floor below. The deflectors can be set at any desired position, thereby regulating the amount of sand which is pulled off for each of the bins.

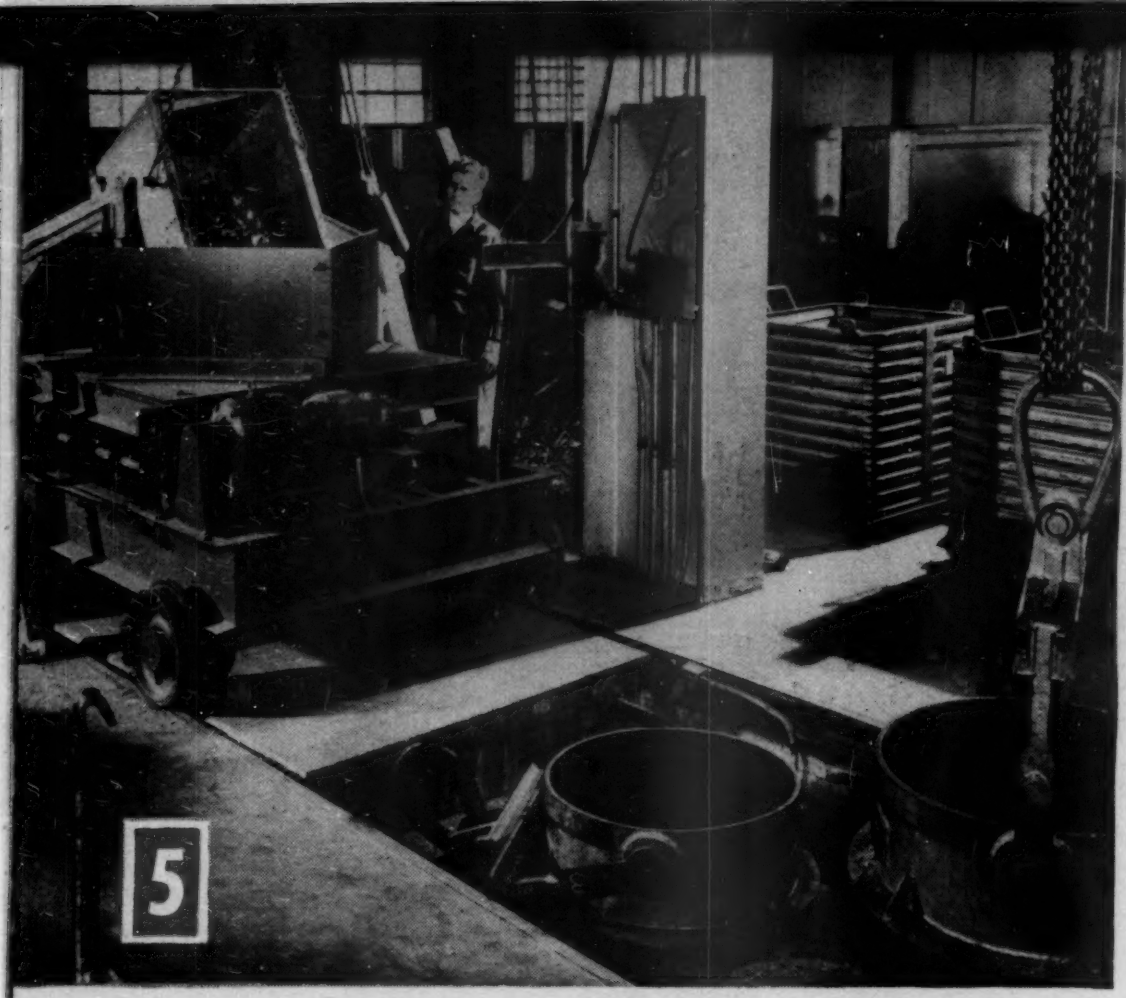
Sand is discharged directly from the bins into the flasks. An automatic jolt machine packs the sand in the flask. Following molding, the patterns are removed, cores installed, and the flasks moved onto the roller conveyors for pouring. This move will vary from about 5 to 20 feet, and is made either by hand or with mechanical aid, depending upon the size and weight of the flask.

On the main floor, where larger castings are made, the mold sand discharges into a sand slinger (which produces large molds), and to four large jolt machines, which produce large molds of the type used for semi-production runs.

*4. **Monorail keeps core-making stations supplied with sand.*** A separate conditioning unit prepares the core sand. This sand is then discharged into a small hopper on a monorail crane which takes it to discharge points above the sand bins that are located over the core-making stations.

As sand is desired by the core-





maker, he merely releases it from the bin above his bench.

Ten hand-molding core benches are arranged along one wall. In addition to the small-core benches, two core blowers and two jolt machines make larger cores. Seventy-five per cent of the cores produced at the present time are made by hand, 25 per cent by machine.

5. Hoist and charging car facilitate handling of raw materials. Raw materials are received by truck or railroad cars and transferred by monorail crane to the storage bins in background at right. Foundry return (heads, gates, and scrap) is moved in toteboxes by lift truck to the storage bins from the cleaning department's cutoff machine.

When furnace charges are to be made up, materials are weighed on a nearby scale, and placed in the charging car by means of an overhead hoist. When full, the 1000-lb. car is pulled out on rails which take it to the loading point. When the bucket charge is completed, an overhead crane hooks onto the bucket and moves it to charging position above the furnace.

Each of the buckets has an orange-peel type bottom, which is tied together with a strand of ¼-in. manila rope. When held over the furnace by the crane, the furnace heat burns the rope, the orange-peel bottom opens, and the charge is dropped into the furnace.

6. Big crane for big ladle, monorail hoist for pouring. Electric furnace taps into large ladle which is handled by overhead crane. On the main floor—where large castings are made—the metal is poured directly into the molds. On the five so-called machine floors, metal is poured into shank ladles (as shown), which are picked up by monorail hoists for transport to the point of pouring.

Molds into which the metal is poured are mounted on pallet type boards which rest on roller conveyors. Each of the conveyors terminates at or near one of the four shake-out points. After the proper cooling cycle, it is a simple matter to move the molds along the conveyors to the shake-out, where the castings are removed.

MANAGEMENT REPORT Date Jan. 23, 1948

Backlog yesterday	423	$	2,850,207.10
Orders entered today	6		33,277.70
	429		2,883,484.80
Shipments today	4		24,805.00
Net unfilled	425		2,858,679.80
Backlog beginning of month	448		3,011,208.30
Orders entered this month	71		442,028.50
	519		3,453,236.80
Shipments this month	91		564,594.00
	428		2,888,642.80
Canceled this month	3		29,963.00
	425		2,858,679.80

Unaccepted orders 0
Phone and wire orders 0
Cancellations 0
Projected month's shipments $ 776,316.86 (125)

New Orders Received Today

1 - 14x54 C
1 - 10x20 EE

EXPECTED VISITORS

Louis Stoner, Arthur Stoner, Bob Riley, Sam Conant - Jacobs Mfg. Co.
W. R. Edwards - Pacific Mills Co.
Messrs. Coates, Goulden & Young - Canadian Ingersoll Rand Co.

OVER-ALL PICTURE of the condition of the business is compiled daily for the department heads, supplies background information for discussions of company policy over the luncheon table. (Figures shown on report illustrated above are hypothetical)

DAILY REPORT TELLS SUPERVISORS STATUS OF COMPANY BUSINESS

JEROME A. RATERMAN • PRESIDENT, THE MONARCH MACHINE TOOL COMPANY, SIDNEY, OHIO

KEEPING department heads "in the know" can become quite a problem in a large plant. At Monarch this problem has been solved by a daily "management report." Both over-all sales and production outlook are covered.

The report consists of the backlog of orders, expressed in terms both of machines and of dollars, and recorded for the current day and for the beginning of the current month.

To these backlogs are added the orders that have been received on the day and during the month. Shipments and cancellations are subtracted. The projected month's shipments, as well as the new orders, listed by type of machine, also are recorded.

In addition, it has been found advantageous to list the expected visitors at the plant during the day, so that all executives will know who will be on hand in case they have something to discuss.

This report gives everyone a good over-all picture of the condition of the business at the moment, and it is also an aid in determining how close the company will come to meeting its schedules and making the desired monthly shipments.

Close study of these reports by each department head gives him information that forms a good background for policy discussions, which are held each noon at a luncheon meeting.

In fact, when no set program has been arranged, the report itself, and what it discloses, is used as the basis of the discussion.

Paperwork is kept simple here...

MATERIAL REQUISITION TALLY SHEET

REQ. NO.	MATERIAL Nipples	TALLY NO.
237718	40-3/4" X 2" Ex. Hy. Black Nipples (or std)	
237718	6-3/8" x3" Galv. Nipples 6	48242 11/28/47
237818	50-½" Close Ex. Hy. Black Nipples (or Std.) 50	48296 12/2/47
237918	12-½" x 2½" " " " " " 12	48289 12/2/47
238818	24-3/4" X 2" Ex. Hy. Black Nipples (or Std.) 24	48332 12/3/47
238818	60-3/4" X 3" " " " " " 60	48332 12/3/47
238818	40-1" X 3" " " " " " 40	48332 12/3/47
238918	30-3/4" x 2 Galv. Nipples 30	48332 12/3/47
239618	6-1½" Galv. Long Screen Nipples with Couplings and Followers	
241618	6-1½" x 2½" Ex. Hy. Black Nipples (or Std.)	

WHAT IS ON ORDER, and whether or not received, may be quickly learned from material requisition tally sheet. Looseleaf in form, it provides invaluable cross-index record, by material, of maintenance purchase requisitions

GOOD PRACTICE IN A MAINTENANCE

JOSEPH HENDERSON • ASSISTANT MANAGER, PLANT SERVICE DEPARTMENT
THOMAS A. EDISON, INC., WEST ORANGE, N. J.

Editor's Note: In Part I of this article in the March issue the author dealt with the question of stockroom personnel, type of stock carried, and how materials are received and disbursed. Part II concludes with descriptions of the paperwork and various techniques for efficient storage.

4. Records and paperwork. The functions and general format of most of the forms used in Edison's maintenance stockroom need not be discussed in detail. Such are the material requisition, purchase requisition, purchase order, notice of receipt of goods, and maintenance shop order. They are known to all supervisors familiar with material procurement, purchasing, and storage problems. Two forms are probably unique, however, and will therefore be given fuller explanation later. These are (1) the material requisition tally sheet, and (2) the daily report of all materials considered for re-ordering.

No material can be withdrawn from the stockroom without a charge to a shop order. Shop order number and location must be marked on each material requisition. Propriety of the charge is checked from several angles.

First, the stockroom clerk checks the requisition against his active shop orders. He is not likely to issue lamps, for example, for a pump repair job.

Later, all requisitions are scrutinized by the general storekeeper to insure correct allocation of cost. This control requires that the stockroom receive a copy of every shop order. These orders are kept in a numerical file until closed, for easy reference.

After a vendor's shipment is re-

...for quick, effective control

DAILY REPORT OF ALL MATERIALS CONSIDERED FOR RE-ORDERING

DATE

NAME OR DESCRIPTION	INVENTORY		6-MONTH QUANTITY	PURCHASE ORDER
	ACTUAL	LEDGER		
E-75 Class A Electrical Workers Gloves	0 3-3	0 6R ✓	18	12 PR. 240618
F-11 Spring Latches	5 4	9 ✓	4	—
Pure Gum Spirits of Turpentine	25¼ 5	30.25 ✓	77	1 Drum 240618
1" 8 X 7/8" Perforated Hanger Iron	120' 100'	220' ✓	480'	300' - 240318
4" Galv. Pipe	20'-7" 21'-6"	42'-1" ✓	44'	2 Lengths 240318
½" x 1¼" Sq. Hd. Machine Bolts	13 24	37 ✓	94	50 - 240618
½" U.S.S., C.P. Heavy Hex Nuts	41 30-100	171 ✓	595	300 - 240618
1½" Ex. Hy. Blk. C.I. Flanges, F.D.	0	1 ✓	2	2 - 240318
1¼ Blk C.I. Ells	10 6	16 ✓	46	35 - 240318

TOO MUCH OR TOO LITTLE STOCK is prevented by daily report. Storekeeper looks for low balances, enters suspected shortages, checks balances against withdrawls and consumption, decides what quantities to re-order

STOCKROOM

ceived and checked in the stockroom, the permanent notice of receipt of goods is relayed to the stockroom office. Here the delivery is recorded in an "order book" which is considered one of the stockroom's most valuable records.

A Complete Record

Looseleaf in form, this book contains the "material requisition tally sheet" (see facing page). All new purchase requisitions are entered in the left column. In the center column the general nature of the material is listed, such as glass, pipe, rope. Receipt numbers and dates are entered in the right column.

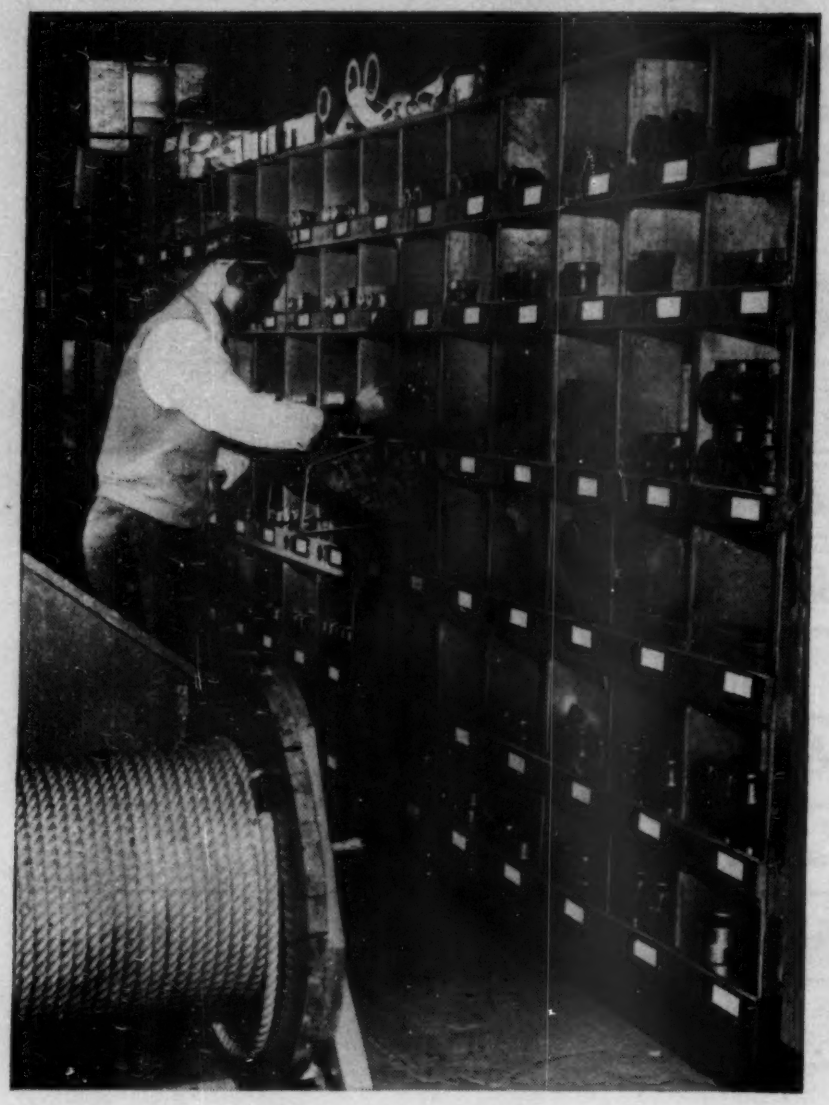
These tally sheets are arranged alphabetically according to the material name. Thus, the order book will show quickly whether any certain material is on order, and if so, whether it has been received. In effect the order book is a cross-index, by material, of all maintenance purchase requisitions. Its uses are manifold. It shows the source of material for years back (order book records are kept for 20 years; others only 5 years) by merely referring to the purchase order number.

In this plant the purchase order number is always the same as the requisition number. Also, the last two digits of all requisition numbers indicate the division that has ordered the material. These details are invaluable in using the order book. A maintenance foreman can get answers quickly on anything he needs to know about previous jobs, such as cost, description, vendor. In conjunction with the numerical file of active purchase requisitions the order book also has all the answers for the stockroom itself on current orders for any specific material. It is the link that ties everything together for smooth operation.

Double-Entry System

Space does not permit a description of the flow of forms and how they operate to register incoming and outgoing materials in the dou-

Orderly storage of maintenance supplies is a "must"



EFFICIENT STOREKEEPING TECHNIQUES include storage in standard marked packages or in units of 5 or 10 for easy count

UTILITARIAN AND COSTLY SUPPLIES are kept in locked closets (right) with wirecloth doors

ble-entry perpetual stock inventory. It suffices to state that this inventory shows at all times the quantities of all items in the stockroom in units and in value. A separate page is used for each item and size. It shows maximum and minimum quantities, weight, size, and bin location.

Used to Be No Check

Prior to the adoption of the perpetual inventory system 15 years ago there was no check on stock except an annual inventory. At such times total adjustments for overages and underages ran each about $700. After the first year of the perpetual inventory system, these adjustments dropped to $150 each. Now they average no more than $10 each. Another way of stating this is that in the first year of the present system 80 per cent of the items checked in inventory against the record; 20 per cent did not. Now 98.8 per cent of the items, averaging about 100 units each, check in inventory against record.

At every replenishment of any stock item, a new average price of the unit is calculated. Also, at every withdrawal the physical inventory is checked with the record before posting, and differences are investigated. Each month a recapitulation is made of withdrawals, showing shop order numbers and materials drawn. This is sent to the accounting department for billing the divisions for what they have used.

No expediting of deliveries is done by the stockroom; this is the function of the general purchasing department. The stockroom does "buzz" purchasing, however, when material is badly needed. Also, periodically it lists straggling items for purchasing to investigate and report back their status.

Control against depletion of stock items below desirable minimums is a major function of the general storekeeper. Formerly the bookkeepers were expected to watch for re-order points whenever posting withdrawals. There were too many slip-ups, however, to continue this method. Nor was it felt advisable to transfer this responsibility to the stock clerks, because this procedure would require duplicate records and complicate their duties.

Today, Full Check

As it is today, at the time of every withdrawal the stock clerk enters the inventory balance (by actual count) on the material requisition. This is not difficult in a stockroom as well-ordered as that at Edison. Every day the completed requisitions are reviewed by the storekeeper. He scans the actual inventory balances, compares them with the amounts withdrawn, and enters on a special form the items he feels should be checked for re-

order. This form is the "daily report of all materials considered for re-ordering" (see page 69). He also enters amount of inventory from the requisition.

The daily report is now checked with the perpetual inventory record as to accuracy of physical count (noted in *ledger* column) and as to the quantities used in the last 6 months (noted in *quantity* column). Sometimes this comparison indicates a safe margin of inventory and retention of present minimums. Therefore the item is ignored, and no purchase requisition for such items is issued. Often, however, either a trend of increasing usage or an imminent sub-minimum is uncovered. Other times a decreasing consumption is discerned. As the case may dictate, maximum and minimum figures on the inventory record are then revised, and the daily report is marked to show which items should be re-ordered, and how much. Amounts re-ordered are the maximums less actual stock on hand. This system has been most effective in keeping pace with current needs, and keeping stock balances from being either too small or too large.

Tool Control

Stockroom control of maintenance tools is equally effective. The stockroom has an adequate supply of stocks, dies, wrenches, electric drills, extension lights, pipe cutters, and similar equipment which are "loaned" to workmen on a material requisition. The requisition is marked *LOAN* and filed alphabetically under the worker's name until tools are returned. Just as for material withdrawals, the requisition shows the number of tools lent on this ticket, balance in stock, and total number out on loan. This method provides a perpetual inventory; in fact, all tools are included in the stockroom perpetual inventory. Formerly a metal number check system was used, but confusion resulted because workmen's checks sometimes were transferred to the wrong tool hooks in the frequent process of checking tools in and out. The loan ticket method has proved foolproof.

The problem of control of stock and tools at nights and during weekends has been solved by depositing a stockroom key with the watchman. Maintenance men can get the key by signing for it and leaving a signed material requisition in a specified rack file.

5. ***Material storage.*** Adherence to a few simple rules in the physical storage of maintenance materials and supplies is a major factor in Edison's set-up. Conservation of all stock, minimum waste and loss, easy disbursement, and ease of taking inventory are the prime objectives. They are attained by:

1. Good housekeeping of premises and every item of stock.

2. Storage of items in standard packages where possible, and storage of broken packages in units of 5 or 10. Standard packs are precounted and sealed on arrival.

3. Storage above the bins or on elevated platforms of reserve quantities that do not fit into bins, with a card placed in bin to show reserve location.

4. Tags on all bulk items which are disbursed by linear measurement, volume, or weight, to show original amount and each withdrawal, hence balance on hand.

5. Segregation of items of each classification, such as electrical, hardware, and pipefittings, in one section of the stockroom to eliminate needless running around.

The stockroom occupies an area only 70x100 feet (including the office) in part of a one-story building. Floor is of concrete, painted deck-gray annually for cleanliness. Almost everything is stored in open-front bins or locked closets, or in marked floor areas for large items. Bin sections and closets are lettered, and bins are numbered. Bins are 14x14x16 inches; closets are 5x5x6 feet, with interior shelves and wirecloth doors. All locations have card holders giving description of material. No tally is kept at the bins, only on the office records.

Storage Methods

Application of the few basic rules just mentioned to storage of 2300 diversified items is shown by the methods in use for a few typical items in the Edison stockroom.

1. Bolts, nuts, fittings, and similar small parts are kept in bins, and stacked where possible in units of 5 or 10 for easy count.

2. Black and galvanized pipe lengths are stored horizontally by size in iron racks.

3. Conduit is stored vertically by size against a wall between horizontal arms.

4 Sheets are kept in a solid shelf rack, about 10 shelves high, open at one end.

5. Wire, wirecloth, packing, etc., are kept in bins or shelves. They are tagged with amounts at start, and deductions are noted as made.

6. Nails always have tare weight marked on kegs.

7. Drums of turpentine, kerosene, or similar fluids are tagged, and deductions are noted for each withdrawal. Spigots are locked.

8. Rags (bought in large bales) are immediately broken up into 5-lb. packages for easy issue.

9. Rope is reeled on a large wood reel mounted on a four-wheeled platform. Smaller sizes are reeled on axle-stands. All are tagged for quantity.

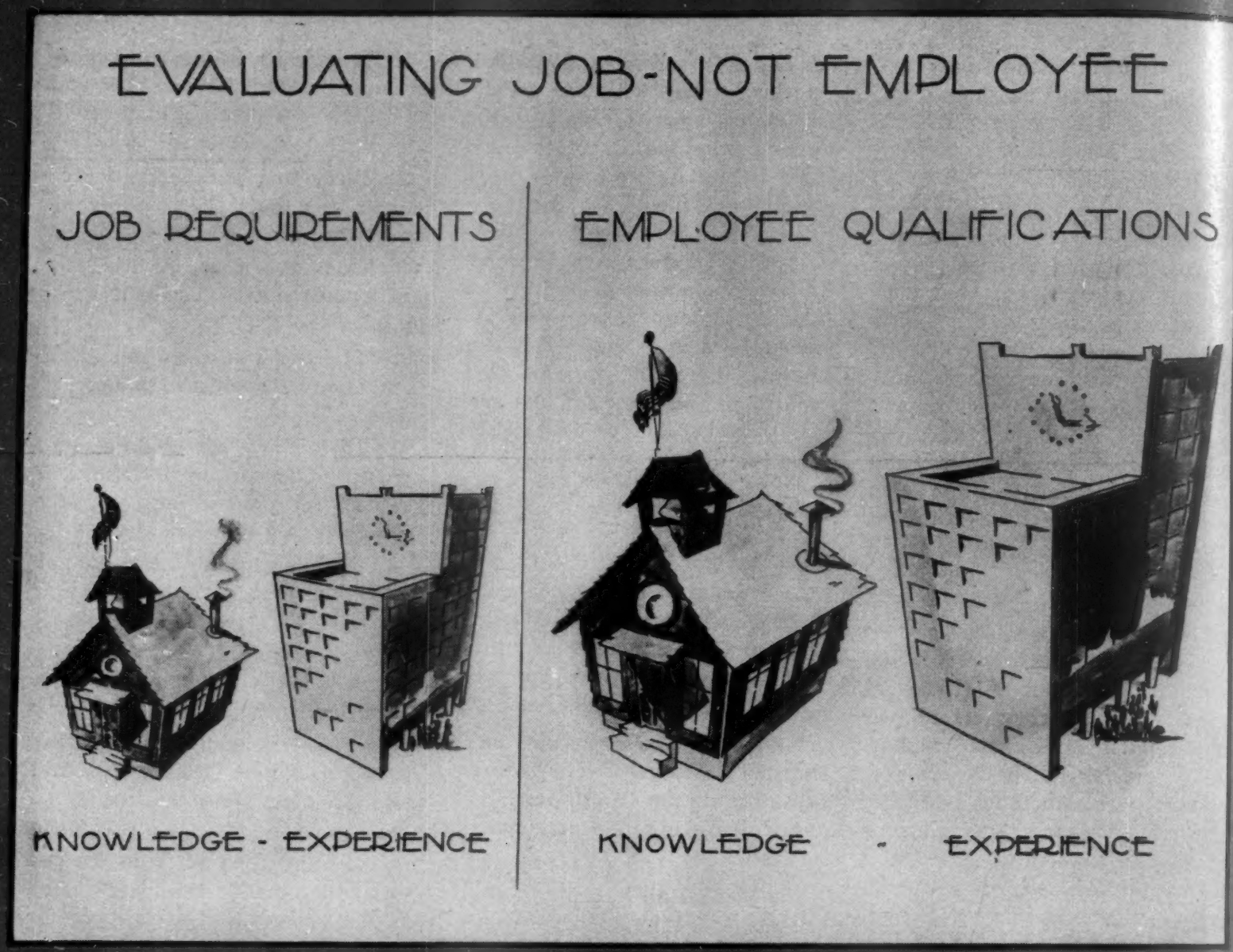
10. Ladders are stored against a wall. Each ladder has a metal tag showing height, type, and number, such as "7 ft. step 37." This insures return of the same ladder that was loaned, and has saved a lot of the headaches caused by return of another man's ladder.

11. All maintenance safety equipment is centralized in a locked closet in the stockroom. Glove costs alone have been cut to one-quarter of the former cost experienced when each division had its own stock.

12. Lubricating oils are purchased in quart cans. Less waste, better control result.

13. Paints are stocked in 1-gal. cans to minimize waste. Paints for job orders, however, may be purchased in 5-gal. cans or drum lots.

The net result of these practices is that physical inventory is always under complete control, and disbursements can be made quickly. This means lower maintenance costs both through material savings and keeping down non-productive time of skilled workmen waiting at the stockroom window.



VISUAL AIDS MADE IT EASIER for top management, supervisors, and workers to grasp fundamentals of job evaluation. Poster above is sample. It helps clear up mistaken notion (see text) that employee, not job, is being rated

HOW VISUAL AIDS WERE USED

Posters helped job analysts "sell" program to top management, supervisors, workers in West Coast movie studio

THADENE HAYWORTH • PERSONNEL CONSULTANT, and
MARJORY R. SARGENT • SENIOR STAFF MEMBER, METRO-GOLDWYN-MAYER STUDIOS
CULVER CITY, CALIF.

To be successful, a job evaluation program must have been accepted and understood by all levels of the organization, from top management to the individual worker. Metro-Goldwyn-Mayer Pictures has proved that effective use of visual aids can "sell" job evaluation to employees, supervisors, and top management.

Management recognized three significant advantages of the visual aids technique over the usual oral or written presentation of a job evaluation program. These advantages were as follows:

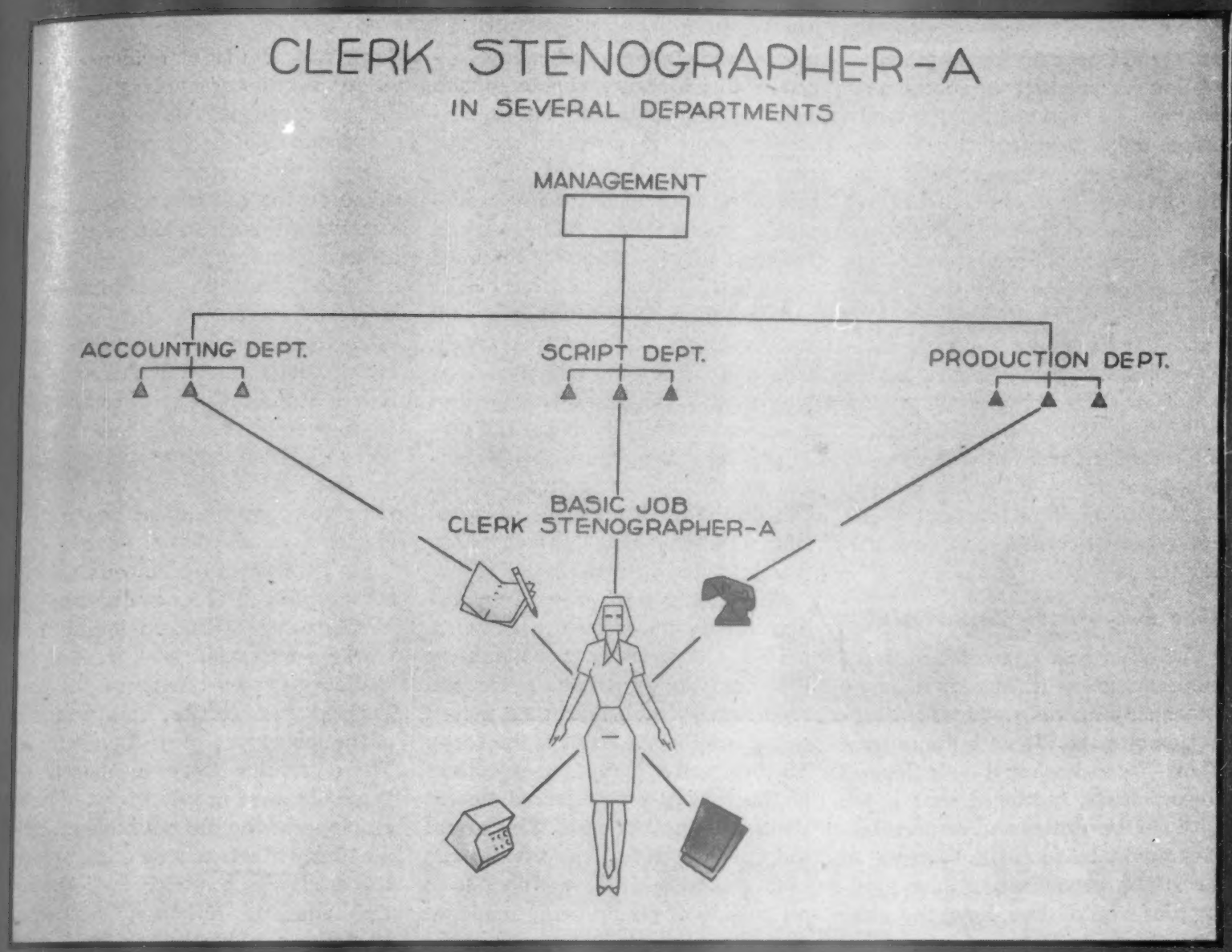
1. Standardization of information.

2. Simplification of complex and abstract facts.

3. Establishment of personal contact with each employee.

This is how the conference program worked:

The job survey staff developed rough designs for the explanatory visual aids to have continuity much like a slide film. The studio art department prepared 16 posters—



HERE IS ANOTHER POSTER USED AT M-G-M to explain job evaluation facts. It demonstrates important point that jobs with similar duties may be found in several departments, and will therefore have the same evaluation

TO EXPLAIN JOB EVALUATION

black and white, and color—30x40 inches in size.

The first four posters explained the purpose of the job survey and the methods used to gather job facts. The next nine were aimed at taking the mystery out of the actual job evaluation process. Posters were devoted to an explanation of how factors used to evaluate the jobs are selected, how jobs are evaluated by the factors and degrees of factors, and the clarification of some of the common misconceptions about job evaluation.

The remaining three posters tied the evaluation process up with wage setting. They related to the translation of job differences into dollar value, and showed how a wage scale can change on the basis of prevailing wage changes, although job differences and relationships remain static.

One in the first group of posters, for example, showed the conference levels or persons to whom the program was to be presented—department heads, department heads and their supervisors, and finally supervisors with their employees. A different color and symbol represented each organization level. This visual representation of the conference levels was designed to point up clearly that the same information was to be given to all persons attending the conference, regardless of their place in the organization.

Another poster (illustrated on the facing page) was directed at clarifying one of the most common misunderstandings of employees and supervisors about job evaluation. The misunderstanding arises out of the employee's very real feeling that he has acquired, over his working lifetime, experience and knowledge

that should be paid for whether or not it is required by the job he now occupies. To explain that job evaluation only measures the knowledge and experience required by the job and not the knowledge and experience of the employee, we prepared a specific visual aid. This poster headed *Evaluating Job—Not Employee,* showed, on the left, a small red schoolhouse for knowledge, and a small office building for experience. They represent the requirements of the job. Enlargements of the same figures indicate what an employee on the job might have in the way of qualifications, but which would not be considered in evaluating the job.

One Job—Many Departments

The other posters treated abstract subject matter in a similar manner. For example, one poster (see illustration on page 73) with the caption *Clerk-Stenographer A—in Several Departments,* indicated that a job with similar duties and responsibilities might be found in any one of the studio departments. Such similar jobs would, then, have the same evaluation. Another poster entitled *Occupational Groups,* explained the theory of levels of difficulty of the same type of jobs. To show this graphically, three clerk-stenographers and three file clerks were drawn. To the left of each of the figures, common duties were shown —i.e., stenography and typing for the clerk-stenographers and filing for file clerks. To the right of the figures, examples of work of varying levels of difficulty were shown. For clerk-stenographer A, telephone and letters—indicating responsibility for answering telephone and writing letters; for clerk-stenographer B—two figures and paper with arithmetical figures—indicating responsibility for supervising two other employees and responsibility for some arithmetical or statistical work; and for clerk-stenographer C—two figures and two volumes representing again supervision of two employees, as well as the added responsibility of research duties. A separate and distinct color was given to each different set of the more difficult duties. The duties of the file clerk were not shown but the same general theory was intended to apply.

The posters were shown in meetings taking place over a 3-month period. Conferences were held in the studio's principal projection room, and visual aids were placed on an easel in the front of the room. The first poster listing the objectives of the survey was referred to and placed on another easel. This visual aid was kept in full view during the conferences, and referred back to as an outline of points being made, at periodic intervals. After each of the remaining posters was referred to, it was placed aside.

Shown to Everyone

Union officers, the business agent, and lot stewards of the Office Employees' International Union, an AFL affiliate representing the employee group being surveyed, attended the first meeting. Studio department heads and their assistants attended the second meeting. Thereafter, the visual aids were shown to supervisors and their employees in the various departments, prior to the analyst's interview of the employees. The average attendance in these groups was 30. Approximately 700 persons attended the conferences. The presentation of the visual aids took an average of 30 minutes. After the formal presentation, the meetings were opened to questions. These questions revealed the employees' understanding of and attitudes toward the job evaluation program.

How did Metro-Goldwyn-Mayer management know that the visual aids were really effective? That would be difficult to prove. But there was plenty of evidence that all organizational levels understood the program and were willing to cooperate in every possible way.

In the first place, the questions asked during the conference meetings were direct, to the point, and at a minimum. This might have indicated lack of understanding. However, when the job analysts interviewed the employees to obtain information about job duties, they found, in the majority of cases, that employees had prepared rough notes of their duties, and did not suggest that unrelated facts about their abilities, length of service, or efficiency be placed on record.

Staff members also questioned employees as to their understanding of the visual aids and found that workers on varied jobs, from messengers to research specialists, had grasped many of the fundamentals of the job survey project objectives. These results were compared to those obtained in interviews of new employees who did not have an opportunity to attend a meeting before the interview. Explanation given by the analyst, although accurate, tended to confuse the employee, and time taken up in explanation alone doubled the interview time.

Effectiveness of the visual aids presentation of a job evaluation program was also strikingly apparent in the meeting held for department heads. The objectives of and necessity for the program were apparently made so clear in 30 minutes that the department heads responded with very active interest and positive cooperation.

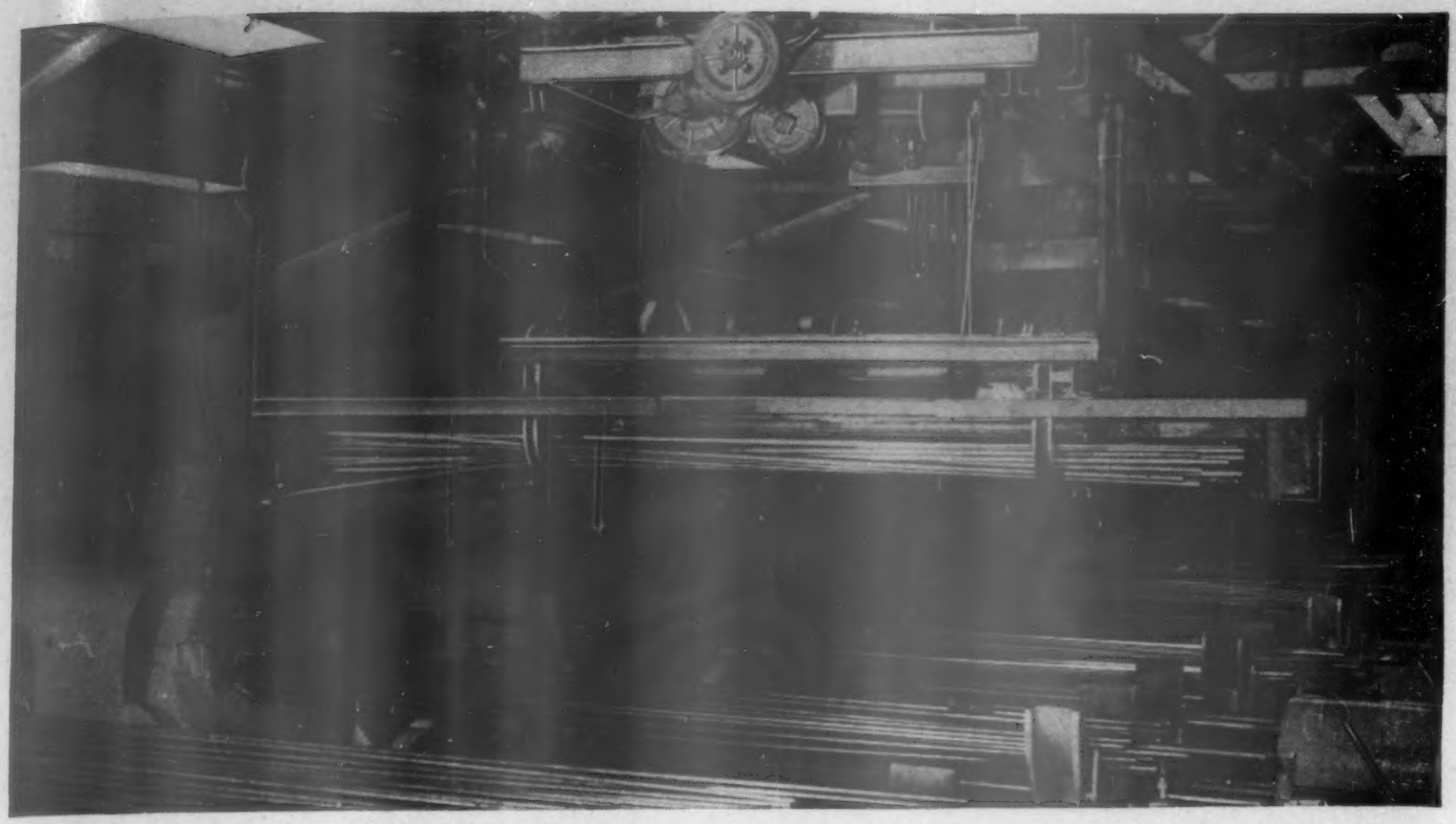
Full Cooperation

While it is impossible to estimate how many out of the total group attending the conferences understood the program fundamentals, it is certain that a large majority did. This understanding not only increased cooperation, and brought the worker and management closer together, but also kept false rumors about the program to a minimum.

Metro-Goldwyn-Mayer management was so convinced of the effectiveness of the visual aids approach in selling job evaluation, that any other personnel programs will be presented by the same method, before being put into effect.

Every Month . . .

AMONG THE ADVERTISING PAGES, these valuable aids to low-cost production: the plant operation man's guide to **WHAT'S NEW IN EQUIPMENT** (page 108) . . . a summary of **LABOR DEVELOPMENTS** (page 200) . . . things **YOU WANT TO KNOW** more about (page 190)



MONORAIL DELIVERS BAR STOCK FROM STORAGE TO SCREW MACHINES IN 10 MINUTES. USED TO TAKE THREE TIMES AS LONG

MONORAIL RAISES PRODUCTION OF SCREW MACHINES

More machines in same space. Eight men formerly needed to supply bar stock and take away chips. Now three

M. M. ROBERTS • WORKS MANAGER, FRIGIDAIRE DIVISION GENERAL MOTORS CORPORATION, DAYTON

A NEW method of supplying bar stock to screw machines has resulted in a saving of 25 per cent in floor space and a reduction of 62 per cent in materials handling personnel at Frigidaire.

When post-war conditions indicated that additional screw machine capacity would be required to meet increased production schedules, a survey was made to determine what space would be available for these machines. The results of the survey indicated that since capacity for other products would have to be increased in the same proportion, no additional space was available. Consequently, a method had to be found by which the additional equipment could be placed in the space already occupied by the screw machine department.

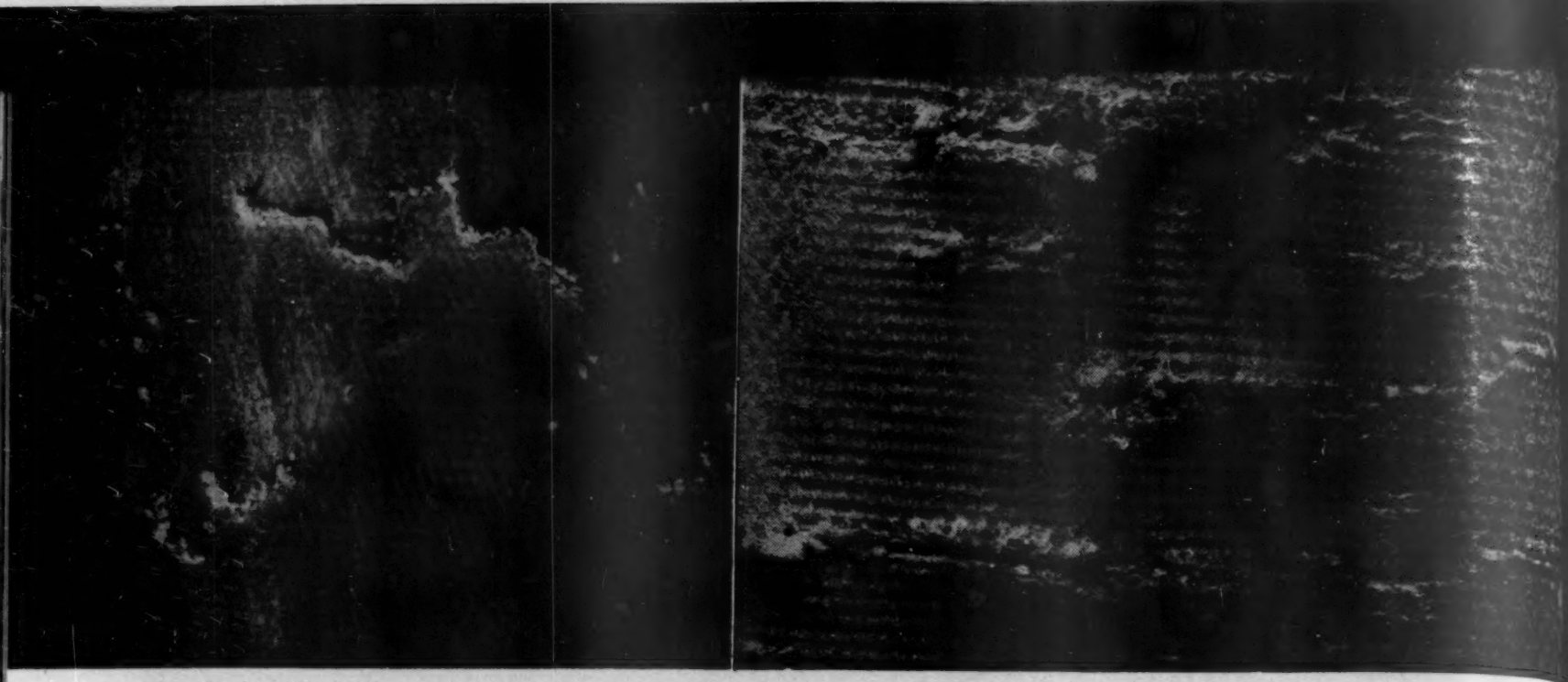
The only way in which this could be accomplished was by reducing the working space between machines and utilizing some of the aisle space then used by materials handlers for stocking the bar stock racks and removing chip boxes.

Choice Made After Study

A careful study was made of all types of available equipment. The only piece of handling equipment which was found to be capable of performing this function in the limited space available was an overhead monorail system. Machines were re-located, new machines installed, and the monorail system was placed in operation on a schedule which required a minimum shutdown of production equipment. This monorail system now supplies approximately 13 tons of bar stock per day to 127 machines. It also disposes of approximately 3 tons per day of chips, which it carries from these machines to a centrifuge operation for oil removal.

Formerly, eight men were required for handling bar stock and chips. Now only three are required, a saving of five operators. The removal of long pieces of bar stock from the aisle to the overhead carriers has improved not only safety conditions, but also general appearance of the department.

In addition to the above advantages, it has also been found that the time required for delivery of a load of bar stock from storage to the machine has been reduced from about 30 minutes to 10 minutes.



BREAKS IN OUTER PLY (left) come from undue stretching when belt is too thick for diameter of pulley. Transverse cracks (right) result from excessive oil that has seeped into fabric and caused rubber to puff out in ridges on the face side, and break

WHEN YOU HAVE TROUBLE WITH RUBBER DRIVE BELTS

Here are five of the most common troubles with rubber drive belts—and some often ignored, but very useful, cures

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CAREFUL adherence to well-known *do's* and *don't's* covering the application and maintenance of rubber drive belts may not prevent all trouble with them. That is not the fault of the rules. They are sound. If followed, they will prevent many a shutdown. However, the *supposedly* obvious corrective measures taken to improve belt drive performance may often be steps in exactly the wrong direction. Most frequent of such mistakes is the attempt to correct belt trouble by applying a heavier, stronger belt. In many cases a thinner belt should have been employed.

Applying the wrong corrective measures usually stems from some confusion between cause and effect, or from unfamiliarity with the bases and factors used in the make-up of belting horsepower tables. What follows, therefore, is pointed towards a better understanding of why certain steps are necessary.

PROBLEM 1
REPLACEMENT OF FLAT BELTS

(It is assumed that the drive as a whole and the pulleys are entirely satisfactory.)

A frequent mistake in the correction of flat belt trouble is the substitution of a thicker belt. To illustrate this point from the standpoint of belt life, try to roll tightly a heavy piece of cardboard and a piece of paper. The outer fibers of the cardboard will readily fracture whereas those of the paper will not.

When a belt is too thick for the diameter of the pulley, the outer ply of the belt can be stretched until it breaks. The left-hand photograph above shows outer ply breaks in an extreme case.

Another way in which a too thick belt fails, is by premature separation of the top and second plies, known as "bootlegging." The fabric has not failed, but the rubber film between the plies has. Too high a stress was developed in these outer plies, overworking the rubber bond between them.

Overstressing the outer ply to the breaking point admittedly is an extreme illustration. But how many belts operating today have their outer plies overstressed to something less than the breaking point, but nevertheless to the point where belt life is a fraction of what it should be?

Many attempts have been made to compensate for or to relieve the extra stress which the outer ply of any belt obviously must sustain while rounding the pulley. In double and triple leather belts, manufacturers long ago endeavored to make the outer ply of higher-stretch stock. With rubber belts, there are various manufacturing means of forcing non-uniform distribution of tension between the inner and outer plies.

Such attempts have invariably

TABLE I. HORSEPOWER RATINGS FOR TOP-QUALITY BELTS AT SPEED OF 3000 F.P.M.

NUMBER OF PLIES	SMALL PULLEY DIAMETER — INCHES					
	6	8	10	12	14	16
4	(3.5)	(4.3)	4.9	5.3	5.7	5.7
5	3.5	4.5	(5.3)	(5.9)	6.4	6.8
6	—	4.1	5.5	6.3	(7.0)	(7.5)
7	—	—	4.9	6.2	7.2	7.8

Figures circled indicate usually recommended belt thicknesses for various pulley diameters

TABLE II. PULLEY SPEEDS IN R.P.M. TO GIVE VARIOUS BELT SPEEDS

Allowance made for average thickness of belt

PULLEY DIAMETER INCHES	BELT SPEED IN FEET PER MINUTE									
	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600
2	3240	3600	3960	4320	4680	5040	5400	5760	6120	6480
3	2160	2400	2640	2880	3120	3360	3600	3840	4080	4320
4	1643	1826	2010	2190	2375	2555	2740	2920	3105	3285
5	1327	1474	1622	1769	1917	2065	2210	2360	2505	2655
6	1114	1238	1361	1485	1609	1733	1856	1980	2105	2225
7	956	1062	1168	1274	1380	1487	1593	1699	1805	1911
8	832	924	1017	1109	1202	1294	1387	1479	1571	1664
9	743	825	908	990	1073	1155	1238	1320	1402	1485
10	671	746	820	895	969	1044	1118	1193	1268	1342
11	618	687	755	824	893	962	1030	1099	1168	1236
12	561	623	686	748	810	873	935	997	1060	1122
14	483	536	590	643	697	751	804	858	912	965
15	449	499	549	599	648	698	748	798	848	898
16	421	468	515	562	609	655	702	749	796	843

TABLE III. MAXIMUM HORSEPOWER RATINGS PER INCH OF BELT WIDTH AT VARIOUS BELT SPEEDS

(Interpolated for five-ply belts from table of maximum horsepower ratings)

PULLEY DIAMETER	BELT SPEED IN FEET PER MINUTE		
	3000	3260	3500
10	5.3	(5.6)	5.9
11	(5.6)	(5.9)	(6.2)
12	5.9	(6.2)	6.5

been found wanting for one reason or another. Sometimes the procedure of deliberately making such unbalanced constructions has resulted in more unintentional and uncontrollable weakness in other directions than could be tolerated, with the result of a poorer, rather than a better, end product.

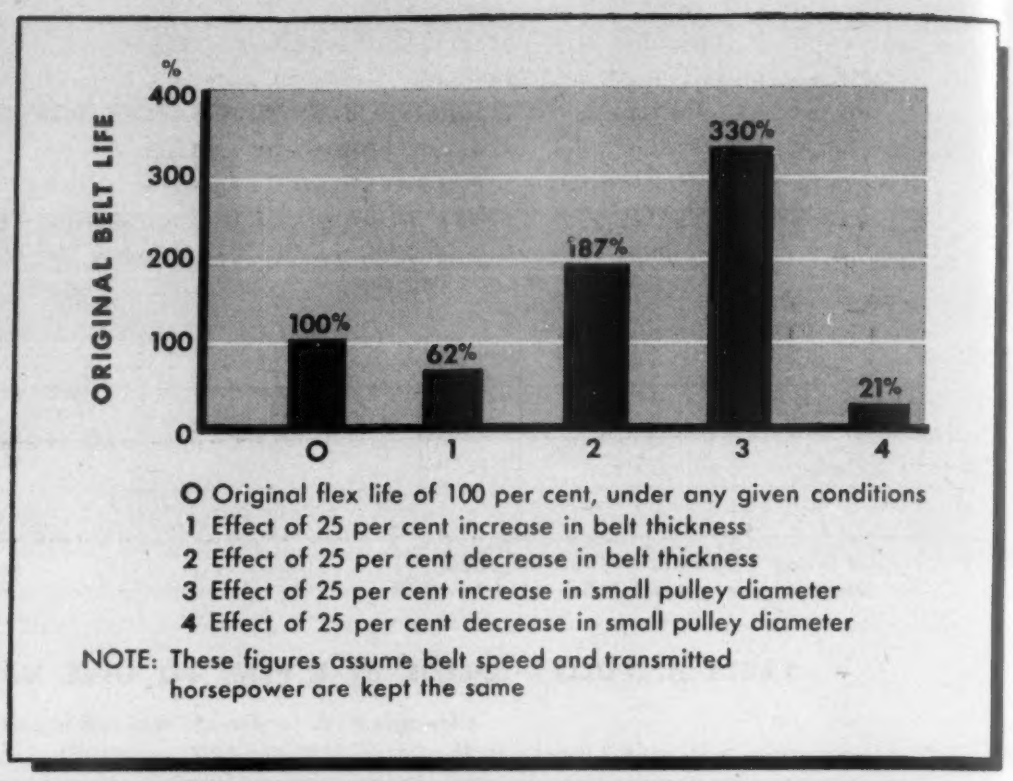
But even when the hidden pitfalls of trying to make special constructions are avoided, compensation of unequal stresses remains a compromise among the theoretical correct amounts for each pulley size. Moreover, any compromise still leaves obvious maldistribution of tension between plies while the belt is running on the straightaway between pulleys.

The real solution in most cases is to substitute thinner, rather than thicker, belting. With a belt of the proper thickness for the pulley diameter, and applied in accordance with the horsepower table ratings, the tension on the outer ply can be as low as one-tenth of a thicker belt.

In those few cases where pulley size forces one to substitute a belt that is so light it does not have the desired horsepower capacity, the drive either should be revamped or a different type of belt substituted; that is, cord construction or the more recent steel cable. Both these belts provide high horsepower capacity on relatively small pulleys, because the load-carrying core of these belts permits them to be made thinner than other belts of equal strength. Of course, in some instances where the present belt is unsatisfactory and the next thinner size is too light, the only solution is to use the lighter ply thickness in a greater width.

For every pulley diameter there is an optimum or desirable belt thickness (number of plies) which gives a maximum or near-maximum horsepower rating. Exceeding this number of plies either increases horsepower but slightly or may actually show a decrease in horsepower rating. At the same time, the extra ply adds proportionately to the cost of the belt, and its life may be greatly reduced.

From Table I it will be seen that with a 10-in. diameter small pulley and a belt speed of 3000 f.p.m. the delivered horsepower varies as follows: Four-ply, 4.9; five-ply, 5.3; six-ply, 5.5; and seven-ply. 4.9. Furthermore, as the number of plies increases, the life of the belt becomes much shorter, as seen in the chart above.



O Original flex life of 100 per cent, under any given conditions
1 Effect of 25 per cent increase in belt thickness
2 Effect of 25 per cent decrease in belt thickness
3 Effect of 25 per cent increase in small pulley diameter
4 Effect of 25 per cent decrease in small pulley diameter

NOTE: These figures assume belt speed and transmitted horsepower are kept the same

BELT LIFE EXPECTANCIES can be drastically affected for good or bad by changes of only 25 per cent in belt thickness or in diameter of small pulley

Consider a drive that involves an 8-in. small pulley and calls for approximately 4.0 horsepower per inch of belt width. Assume that the five-ply belt on the drive is not lasting as long as it should. If the engineer follows rather common practice and puts on a six-ply belt with the idea of getting more "beef" into the belt, Table I shows that he gets a smaller horsepower rating (reduced from 4.5 to 4.1). Not only that, for from the chart it also is seen that the life of the new belt is extremely reduced. This reduction of belt life is accompanied by an increase in cost of 20 per cent.

On the other hand, assume that the engineer substitutes a four-ply for the former five-ply belt. Although the horsepower rating is slightly lowered, from 4.5 to 4.3 per inch of belt width, it is still 7 per cent over the 4.0 horsepower required. Also, belt life has been increased about 1¾ times over the old five-ply belt, and at a 20 per cent reduction in cost. Not a bad trade!

PROBLEM 2
REPLACEMENT OF PULLEYS

(Assuming belts are adequate).

Here, the pulleys are not adequate and should be replaced. But by what size?

When selecting new pulleys a good rule of thumb is: The diameter of the small pulley should not be less than the required belt width.

For example, consider a drive consisting of a 40-hp. motor revolving at 1120 r.p.m., and driving a 10-in diameter small pulley. It is expected to handle possible starting or peak loads of 60 horsepower, 150 per cent over capacity. Belt speed in feet per minute (Table II) is 3000.

The rated horsepower per inch of belt width for the various plies (from Table I), using a 10-in. diameter pulley, at this belt speed is: Four-ply, 4.9; five-ply, 5.3; six-ply, 5.5; and seven-ply, 4.9.

The maximum rated horsepower with the maximum desirable width of belt (following the rule of thumb) would be 55 horsepower for a 10-in., six-ply belt.

To obtain the desired 60-hp. rating and still use a 10-in. pulley would require going to a 12-in. belt (the next standard width).

A five-ply, 12-in. belt is rated at

63.6 horsepower, adequate for the conditions of the problem. A 12-in. belt on a 10-in. diameter pulley should make a good drive and one that is fairly well proportioned. However, note that it is slightly outside the limits of the rule of thumb. Therefore, it is probable (depending upon centers, speed ratio desired, etc.) that a better proportioned, and possibly a less expensive, drive would be obtained by using a slightly larger diameter motor pulley.

Using the next larger standard-diameter motor pulley (11 inches), the following figures evolve. Interpolating from Table II, a motor pulley speed of 1120 r.p.m. gives a belt speed of 3260 f.p.m. for the 11-in. diameter pulley. Table III shows a rating of 5.9 horsepower per inch of width or 59 horsepower for a 5-ply, 10-in. belt—adequate for the 60-hp. peak load, and (as explained later) easier on the motor bearings.

If one wishes to lean over backward in following the rule of thumb about keeping pulley diameter as great or greater than the width of the required belt, a 12-in. diameter pulley might be considered. This would produce a belt speed of 3600 f.p.m. (Table II), and a rating of more than 6.5 horsepower (Table III); so that a 5-ply, 10-in. belt, at 65-hp. rating, would be more than adequate.

In general it is much better to go to a larger diameter small pulley than to increase belt width. When the rule of thumb previously stated is thus administered, it is a good guide to designing an efficient, trouble-free, low-cost drive as far as belt life, stretch, and other desirable belt characteristics are concerned. It is also a good rule to follow to avoid overloading and possibly damaging the bearings in the motor or a machine.

For example, in the foregoing problem with a 10-in. pulley, if the belt were tightened sufficiently to handle a peak of 60 horsepower the total belt pull on the bearing would be approximately 2000 pounds. With a 12-in. pulley, the pull would be only about 1700 pounds, or 85 per cent as much.

The leverage on a bearing is important, too, in the preference for a narrower pulley of larger diameter. Use of a pulley 12 inches wide instead of one 10 inches wide, for example, would increase by 1 inch the center-to-center distance (or leverage) along the motor shaft between bearing and pulley, or from about usually 9 to 10 inches overall. With the narrower pulley, therefore, 85 per cent of the belt pull on the wider pulley times approximately 90 per cent of its leverage would give about 75 per cent as much motor bearing pressure. Or stated another way, the result is a 25 per cent reduction in bearing load.

PROBLEM 3
CROWN ON FLAT BELT PULLEYS

If perfect alignment of pulleys could be obtained and retained, crown would not be necessary.

It is virtually impossible to retain perfect alignment over any period of time, because foundations settle, temperatures change, bearings wear, and so forth. Therefore, some crown is required in order to steer the belt under anticipated minor misalignments.

Excessive crown, however, is too often used and sometimes even mistakenly specified when pulleys are ordered. This is detrimental in four important ways:

1. Speed is higher in the center of the pulley face than at the edges. Hence the belt will travel at some speed in between that of the edge and the crown of the pulley. In effect, the center of the pulley face is traveling slightly faster than the belt, and the edge slightly slower. This produces a continuous creep or "worming" between the belt and pulley faces. Creep represents not only a frictional power loss, but unequal wear both on the face of the belt and of the pulley, with consequent loss in tractive effort.

If the crown is excessive, it can result in actual polishing or glazing of the face of the belt, particularly at the center. There the loss of traction is considerable. Excessive belt tension is required to compensate for it. The result is a decrease in the life of belt, fasteners, and bearings.

2. The belt is obliged to stretch unduly along its center periphery, to conform with the crown. This action tends to concentrate the driving effort or traction in the center portion of the belt, building up unduly high pressure between the belt and the pulley face at the center. Use of belt dressing in such instances often is of little value because the high pressure tends to squeeze the belt dressing to the sides. Here there is little tractive effort because of the lower pressure between the belt and the pulley.

3. Overtension of the belt center shortens belt life.

4. Stress is concentrated in the center of the fastener group, which complicates the fastener problem.

Years ago it was customary to use pulley crowns much greater than customarily furnished as "standard" today. Although a very high crown can be *tolerated* by belts having a high stretch characteristic, the trend is toward belts with low stretch, because they do not have to be taken up so frequently. The new steel-cable belt is an extreme example of low-stretch characteristics. Therefore, avoid placing orders for high crown pulleys today.

Most rubber belts (except steel-cable type) will function satisfactorily on present standard-crown pulleys. If old pulleys with high crowns are on the drive, it will perform better if the crowns are reduced by grinding.

The present standard crown is a taper of approximately $\frac{1}{8}$ inch per foot. On pulleys 16 or 18 inches wide some manufacturers drop to less taper than this standard. This is good practice.

Steel belts require special, extra-low-crown pulleys usually specified by manufacturers of steel-cable belts, with crowns usually less than half the present standard.

There are three rough checks to determine whether a crown is too high, resulting in lighter belt contact at both edges of the pulley face. These are to be made when drive is idle:

1. See whether light is visible be-

tween the edge of the belt and the pulley face. This usually is noticeable only on wide belts.

2. See if a feeler gage can be inserted easily at the edge of the belt.

3. Notice whether the belt gives evidence of little wear at the edges and excessive wear at the center.

PROBLEM 4
V-BELT SHEAVES

With V-belt drives a variance in pitch diameter often develops among the grooves in a given sheave, through irregular wear of the sheave faces. Therefore, some belts are riding at different levels and running at different speeds from the other belts. The difference may be slight, not over 1 per cent, but it is appreciable from an operating standpoint, for these reasons:

1. The belts running at a higher speed will try to pick up a greater share of the load.

2. If carried to the extreme, because of excessive sheave wear the faster riding belts may actually try to carry all the load, with the slower moving belts carrying none.

3. Carried one step further a point can be reached where the slower moving belts actually are dragging backwards on the faster moving belts. Hence, the faster belts not only have to handle the active load, but also the additional load imposed by the laggard belts. At this point, the system is better off without the slow belts.

Long before reaching this condition, corrective action should have been taken.

Keeping a record card listing belt drive performance is helpful. Cases have been found where one set of V-belts was in service for 2 years, the next set lasted 18 months, the next set 12 months, and so on. Unless there has been a gradual increase in load, it is possible that this condition results from dissimilar wear of individual grooves.

One way to determine experimentally whether uneven sheave wear exists, is to stop the drive and draw a chalk mark across the whole set of belts. Then start the drive, let it run for several revolutions, and stop it. The probabilities are that the chalk marks have not remained square across the whole set of belts.

A small change in the location of the marks is nothing to be alarmed about. It is normal and to be expected. In fact, it has been allowed for in the horsepower ratings assigned to V-belts. These ratings make allowance for less than 100 per cent cooperation within a set of belts. This allowance is a necessary design consideration, recognizing the manufacturing tolerances in both belts and sheaves.

It is impossible to fix the amount of dispersion that is acceptable for all cases. It will vary with length of belt, size of sheave, the load carried, tension, and make and type of belt. Extreme dispersion of the chalk marks merely directs suspicion to those belts in the set that are far out of line. This quick check can be made without removing the sheaves.

If one belt leads by any large margin, one of two things is wrong:

1. Grooves are worn unevenly.

2. Belt is dissimilar as to stretch, cross-sectional dimensions, or other characteristics.

Suppose it is discovered that two out of eight belts in a set show a large amount of dispersion. Trade the positions of these two belts with another two belts in the same set, similar to switching tires on an automobile.

If it is always found that the same grooves create the greatest dispersion, the grooves are at fault. If the same two belts are always off, the belts are at fault.

If there is an indefinite pattern but belt trouble is still being experienced, some thought should be devoted to possible causes other than the belts or sheaves in themselves.

PROBLEM 5
OIL AND DRESSING

There are oil-resistant synthetic belts which will solve a troublesome belt problem where getting oil on the belt cannot be avoided. It is still true however, that oil should be kept off belts as much as possible, even when oil-resistant belts are used.

Excessive oil can have two serious results:

1. Oil seeping into the fabric puffs the rubber behind the ply into a ridge on the drive face of the belt. As it travels over the pulley the ridge wears off and leaves either a series of transverse cracks in a wide belt (see photograph, right, on page 76) or large transverse cracks in a small belt which frequently rupture the entire belt width.

2. Oil on the pulley may also cause a convex curl in the belt. Obviously this reduces contact surface with the pulley, which in turn reduces the power delivered.

Although oils are recognized as being detrimental, it is not always realized that belt dressings may contain oils that are harmful to belts. The most serious offender is neatsfoot oil, which should never be used on rubber belting, since it is a strong solvent for rubber. Dressings containing mineral or animal oils also are to be avoided.

Those that contain vegetable oils, such as castor oil, are not too harmful to rubber if used sparingly.

Rosin is a poor dressing because it tends to harden the surface of the belt and contributes to eventual glazing. Under some conditions it can be a cause of patches of the belt face being pulled off.

If in doubt about the possible presence of injurious oils in liquid dressings it is usually safe to use a stick dressing having a wax base.

In general, dressing should not be used on V-belts. Because of their wedging action, V-belts get plenty of traction in the sheave. Cases have been found where the new-belt coefficient of friction was excessive, to the detriment both of the belts and of the drive under shock load conditions. Use of dressings on the belts would only tend to aggravate that condition and might strip off the envelope fabric of the V-belts.

LOOKING AHEAD IN LABOR

Last-minute round-up as we go to press

Critical months ahead — April, May through August. That's the signal the Taft-Hartley law gets as it takes on new tests and sights bigger ones ahead.

Right now, T-H tools for dealing with "national emergencies" undergo their first trials against CIO in meat-packing plants and the AFL in Oak Ridge's Atomic Laboratory. *Whether they're strong enough to cope with the likes of John L. Lewis, remains a question mark.*

Immediately ahead: The new labor law watches hopefully the climax of third-round wage bargaining in electrical equipment, automobiles, and steel.

Later comes the Supreme Court's answer to the ban on union political expenditures. Philip Murray's indictment was dismissed on constitutional grounds. Judge Moore's ruling covered a lot of ground, went far beyond the free speech issue. If it's upheld, the lid's off completely on union spending. But not for corporations. The Corrupt Practices Act still holds for them.

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July 1 brings the curtain down on any payroll check-off that's not voluntarily authorized by the worker. After that, compulsory deductions for unions are taboo. So you can expect union members in your plant to spend a lot of time getting check-off cards signed.

At General Motors, UAW-CIO takes in more than $300,000 a month from 225,000 employees under the 1946 compulsory check-off agreement. Now it seeks a union shop, has put up $75,000 in prizes for those signing up most new members.

In this respect, one effect of Taft-Hartley has been to raise union shop as new goal of unions which previously were satisfied with the War Labor Board's maintenance of membership. *NLRB records show unions winning 99 out of 100 union shop authorization polls. Up to February, they won 1643, lost only 18.*

August 21 will bring the last deadline. That's expiration date of many closed shop contracts signed just before the new law took full effect. Most of these are in building trades.

NLRB Counsel Denham may have to hold 10,000 elections in more than 600 areas on union shop elections among building crafts to take the place of the closed shop. To smooth transition, Denham will let employers sign union shop contract without waiting for NLRB to act, providing it's not made effective until workers approve it in NLRB poll.

Denham's ruling on union shop is not in line with intent of Congress. It strengthens union's hand, increases pressure on employer to grant demand. *Worker approval, coming after objective is won, becomes routine.*

Whatever happens in these critical months, Congress does not plan to change the law. *Not this year.* Whatever storms arise, it hopes to ride them through with what it has.

There's a chance for more Law, however, to take care of Lewis if Taft-Hartley can't keep his miners in the coal pits. *That's because T-H, if it fails to end an emergency, puts it up to Congress to find a solution.*

Up to March 15, the law had worked well. That's the finding of a majority of the Senate-House "Watch-Dog" Committee. But on that day the coal and meat-packing strikes got rolling.

Final report of Senator Ball's committee will come January 3, 1949, when the new Congress convenes. Ball cites three parts of Taft-Hartley Act which may need changing:

1. Ceding jurisdiction to state labor boards whose policies are not in conflict with federal law. States would have to pass baby Taft-Hartley laws to qualify. None has. Thus, NLRB is burdened with cases previously handled by states.

2. Ban on political spending by unions and corporations. Supreme Court's decision may force revision.

3. Handling of cases by NLRB. Committee feels too much time spent reaching decisions, hopes to speed up procedures.

On other labor legislation, here's this year's prospect:
Anti-discrimination law — *No.*
Labor extension service — *No.*
Equal pay for women — *No.*
Higher minimum wage — *maybe, but probably no.*

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More productivity statistics may flow soon from BLS, become tools in bargaining. Lever Brothers follows soap price cut with 11-cent wage boost, credits higher productivity. Budget cut shaping in Congress may hurt BLS usefulness.

Rising political tension, here and abroad, widens the left-right breach within CIO. At same time, AFL and CIO work closer together. We'll look at this situation next month.

LOOKING AHEAD IN BUSINESS

Last-minute round-up as we go to press

What's going to happen to U. S. business in late 1948?

Business forecasters once again are saying, almost without dissent: *Look out for trouble in the last quarter.* Reinforcing their pessimism are widespread reports that some businesses are slowing down.

But they can be wrong. *Barring war, famine, or pestilence, and with the help of tax cuts, chances are business will continue at a high level through '48 and into '49. Here's why:*

1. Purchasing power is trending upward. The farmer still is the consumer industries' best customer, despite the break in farm prices. Over-all, the break turned out to be a "good break," dampening inflation, sobering people, but ruining practically no one.

2. Sheer momentum will keep the economy going at a high level in the next few months. We have reached the goal of 60 million jobs. Our needs for housing, automobiles, roads and bridges, schools and hospitals, and all that goes with them, can keep basic industries running full tilt. A record 3.9 million new babies in 1947 is one measure of a population increase which, in itself, is a sizable market.

3. Military expenditures, Marshall Plan spending, foreign relief, and recovery projects will prevent anything more than a gradual sloping off in prices.

4. Basically, the boom is not speculative. A decline in business would not collapse the banking system, for instance. It is fabulously strong, has seen only one bank, and that a small one, fail in the last two years.

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One thing could be disturbing, however. As is shown in the McGraw-Hill survey of business plans, reported here in February, manufacturing companies will have finished 85 per cent of their post-war expansion programs by the end of 1948. If business investment in new plants and equipment slows down in 1949, all business may slow down with it, as it has in past ups-and-downs.

Four out of five of the dollars financing manufacturers' $16-billion-a-year expansion programs are coming from company profits and reserves now, the McGraw-Hill survey shows. But reserves are being used up and profits will be cut as new plants and equipment come in to production this year.

By year's end, industry must look to the investment markets to supply three times as much money if it is going to replace obsolete equipment and buy new plants and equipment at something like today's high rate. With the stock markets soggy, that prospect is poor now.

But tax cuts can perk up the markets. Upper-bracket income tax payers will save through tax cuts $1 to $2 billion that they are now giving the Treasury. That's enough to give the markets a shot in the arm.

A reviving stock market might well draw in other billions now in the cellar. That would stimulate business's buying of new plant and equipment — and, with it, all business. Getting over that hurdle, the shortage of investment capital, would extend prosperity's lease on life.

How much of a lift will develop, will depend on the size and timing of tax cuts. But the prospect now is that the U. S.'s problem will not be a slowdown in business — but how to handle more inflation.

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Overshadowing all else that can upset this outlook is the coming showdown with Russia. Each new made-in-Moscow crisis adds to the weight holding down the stock market. It is reflected in business thinking about inventories, expansion, long-range planning. But it also helps boost military budgets, knocks out serious opposition to more foreign relief and recovery measures. Taken together, these government expenditures underwrite a high level of industrial activity — producing the materials for peace and/or war.

At the spring showing of the 1948 model of U. S. Business, observers saw many of the same features that were introduced last spring. There were rumbles of setbacks in soft goods, rumors of new cuts in employment as buyers' markets catch up with more lines, a new tightness in money at tax time, a little bit of take-in in the cost of living, but glimpses of new rises in prices to be developed later. In the meantime:

Production, as measured by the Federal Reserve Board Index, is about 3 percent higher than a year ago.

Employment, despite scattered reports of layoffs, is 1.6 million higher than it was a year ago, according to latest Bureau of Census reports.

Prices of commodities other than farm and food, although not inflated as have been farm prices, are up 15 percent as measured by the Bureau of Labor Statistics. And they are likely to go upward, although at a somewhat slower rate than a year ago.

Wages are being boosted as Round III spreads. Here again an upward trend, about like last year's, although Round III will be smaller than Round II.

So — barring the actual outbreak of war — the outlook is: Good business through '48.

BONUS OF 5 PER CENT FOR EACH UNIT OVER STANDARD BOOSTED PRODUCTION, HELPED WORKERS MEET THE HIGH COST OF LIVING

BONUS PLAN RAISES TAKE-HOME PAY 70 PER CENT

The only source of higher wages is greater output. Here is a pay plan based on that great principle

DUDLEY STEELE • PRESIDENT, ACME SASH BALANCE COMPANY, LOS ANGELES

MULTIPLE benefits for management, employees, and customers are continuing to pile up at the plant of Acme Sash since adoption of a simple but effective incentive plan.

Instituted November 1, 1945, the Acme plan is not based on piecework, was not established following an extensive time study, and has not been revised to adjust for efficiencies attributed to new equipment, better designs, or technique improvements.

The plan in fact is merely the core of an industrial relations program that is both enlightened and successful. It was adopted to improve relations among employees, to create understanding between employees and management, increase efficiency, and improve the firm's competitive position.

Announcement of the program was made to the firm's production and office people at a dinner given by the company. Employees were told details of the program, and were encouraged to "take their hair down" about it. They did. The question-and-answer session that followed aired all phases of management's proposals. In the end it was voted to give the plan a try.

More Units, More Pay

Taking the previous six months' production average of 15.143 sash balances per man-hour as the base, and reducing it to the even figure 15, the incentive phase of the program offered production people a straight 5 per cent of each individual's base pay for each unit of increase per man-hour over 15. Thus, 16 units would add 5 per cent of each worker's paycheck, 17 units would add 10 per cent, 18 units would add 15 per cent, and so on without limit.

Base pay rates in the Acme plant range from $1 to $1.20 per hour. As an initial goal, management announced that the first week's production target would be 19 units per man-hour, which would give production people a 20 per cent boost in their pay checks.

At the close of the first day, employees stopped on their way out of the plant to rib the management. They had averaged 24.49 units per man-hour instead of the hoped-for 19. Bottlenecks reduced the average to 19 for the first week, however.

Enthusiasm remained high, and still does, and production climbed steadily until the current average is 27 units per man-hour. An all-time record for a single day, set some weeks ago, totaled 32.89 units, or approximately 115 per cent over the average of pre-bonus production.

Without improvements creditable to management, it is estimated that current production would average about 20 units per man-hour, instead of the 27 units being realized. Management, however, has made no change in the bonus rate to offset the 7-unit gain it might take credit for and which has required considerable added investment.

It is this adherence to its original bargain that appears to be the key

factor in the continued enthusiasm of the employees for the bonus plan. The efficiency increase has been such, creditable of course both to employee effort and to management decisions, that price increases have totaled only 14 per cent, despite increased costs all along the line.

As part of the incentive plan, base pay scales are reviewed on an individual basis each six months, with most employees being granted hourly increases, generally in 5-cent units, until their base reaches maximum for the job. With take-home pay checks up approximately 70 per cent weekly, because of the bonus, employees' earnings have been satisfactorily meeting rising living costs.

Bonus for Office Workers

Office workers likewise share in the incentive plan, being paid bonuses equal to 50 per cent of that paid production-line people. Office bonuses range from $43 to $95 a month and are paid monthly. Production bonuses are paid weekly.

Although the Acme staff is 40 per cent women, all employees are treated alike under the bonus plan. Base pay rates, however, vary because they are set for the job, and jobs filled by women are generally those requiring less mechanical skill.

Heart of the Acme program is participation by employees in the fruits of the combined efforts of both employees and management. Confidence and incentive have been instilled and maintained because management has not attempted to curtail earnings by readjusting bonus rates, even when it might have justified it because of management contributions.

GETTING BYPRODUCT POWER FROM PROCESS STEAM

DAVID MOFFAT MYERS • MYERS, FULLER & ADDINGTON, NEW YORK

If your manufacturing processes require a considerable and not too erratic demand for steam, it will pay you to investigate the economy of generating some cheap electrical energy as a byproduct of that process steam.

As far as fuel is concerned, such energy often can be obtained without any increase whatever in the fuel bill.

The engineering theory upon which this economy is based is easy to understand, and widely practiced.

To get power out of the process steam it is necessary only to generate the same quantity of steam at a higher pressure and temperature and expand it through a turbine unit into the process steam mains at their regular pressure. The turbine acts like a reducing valve, but while lowering the pressure it generates byproduct electrical energy at the same time.

To raise the steam to the higher pressure requires a few more B.t.u. Usually when such a plan is executed, modern boilers of higher efficiency are installed. This higher efficiency of steam generation usually can more than compensate for the extra B.t.u. needed for the higher pressure steam.

No Extra Fuel Needed

Therefore, the byproduct energy is entirely free of any cost for additional fuel.

The added costs for such a program pertain to fixed capital charges for interest, taxes, and depreciation, together with maintenance and such added attendance as may be called for in any particular case.

The higher the pressure needed for process, the higher will be the initial pressure to the turbine for a given electrical output and *vice versa,* but 150- to 200-lb. process steam makes easy going for a modernized byproduct power plant. While each problem must be individually considered and engineered, a general idea of results attainable can be secured by a look at the following figures:

1000 kw. per hour are obtainable as a byproduct of 40,000 pounds per hour of 95-lb. process steam by supplying this steam to a turbine at 425 pounds with proper degree of superheat.

1000 kw. can be had as a byproduct of 42,000 pounds per hour of 145-lb. process steam by using 600 pounds at the turbine.

1000 kw. are available as a byproduct from 50,000 pounds per hour of 195-lb. process steam raised to 625 pounds at the turbine.

In every case more power is obtainable from the same steam by raising the pressure at the turbine throttle.

The best results, of course, are secured when variations in steam and power demands coincide reasonably well.

Producers of paper, chemicals, rayon, plastics, rubber, and leather, bleachers and dyers, and others with large steam demands, who have not already adopted byproduct power should start investigations of the possibilities in their plants. The power company engineers all know they cannot make or sell electrical energy to compete with a well-engineered byproduct power supply.

MACHINE-LOAD CHARTS PERMIT SCHEDULING 18 MONTHS AHEAD

MURRAY A. YOUNG • TIME STUDY SUPERVISOR, THE BLACK-CLAWSON COMPANY, HAMILTON, OHIO

UNDER a new system of long-term machine loading, The Black-Clawson Company is able to schedule deliveries, plan machine tool capacity changes, and enlist subcontracting sources soon after a contract is made.

Because a large portion of the equipment manufactured by this company requires months of design work before being built to specific customer needs, such a system became urgent and invaluable.

An advance loading method was adopted for estimating contract hours by critical machine groups, miscellaneous machines, and assembly time from the sales estimates, experience data on similar jobs, and from a preliminary engineering layout of the job.

Contracts can now be scheduled for production up to 18 months in advance of shipment. The firmness of such schedules, however, is partially determined by delivery of material purchases and other related problems.

Advance loading and weekly progress data are tabulated on four forms, 8½x11 inches, to provide a constant and accurate check on the status of the contract as well as a permanent record for future use. After a job is planned and a loading schedule is made up, the forms are filed until the start of production.

During production, the hours used by machine groups on each contract are accumulated daily and subtracted weekly from the original grouped load to show the actual number of hours ahead of schedule. Hours used weekly are also divided by total-hours-loaded to show job progress as a per cent complete.

Description of Forms

Production control load and progress record (Figure 1). This form is used (1) for monthly reporting of total hours loaded on contracts scheduled to be shipped in any one month; and (2) for weekly reporting of hours ahead and hours used on this same monthly schedule.

Production control record (Figure 2). One copy is prepared for each individual contract order number. It shows total hours loaded and provides for daily posting of hours used on each of the groups.

Production control record weekly summary (not shown). This form, a slight modification of the production control record, is made up in two copies. The white copy simply carries weekly postings of total hours used on an entire contract. Contracts may consist of several hundred order numbers representing various parts and subassemblies. A buff (or second) copy carries total hours loaded on on entire contract. Additions, subtractions, and cancellations of hours are recorded on it.

Production control used-hours record (not shown). Simply another summary form. After a contract has been completed, total hours used are transcribed to this form from the load and progress record. This then constitutes a reference for estimating and advance loading on future contracts.

Sequence of Operations

Machine Group Loading. The time study department begins the machine group loading operation immediately after receipt of a contract order number breakdown from the order department—except where it is desirable to await preliminary layout from the engineering department. The original sales estimate, contract specifications, elevation prints, experience records, standard time values, and cost department records are all used in establishment of accurate loadings. Where, for example, ten individual job orders are included under a contract, ten copies of the production control record (Figure 2) are prepared and loaded, one per order. One production control weekly summary is prepared. It carries the total of the loadings taken from the ten copies of the production control record. One copy of the production control load and progress record (Figure 1) is prepared. Finally the production control used-hours record is prepared for recapitulation purposes at the completion of the contract.

Scheduling. All contract machine loading information is available to the production control office and its affiliate department, contract coordination and expediting, for guidance in scheduling shipments, planning for adequate machine tool capacity, determining needs for subcontracting, and coordinating schedules for engineering and supply for purchased materials.

Early scheduling projections are available in turn to the sales department as an aid in directing sales effort, supplying information to customers, and in determining promise dates on inquiries for new work.

Production Posting. Manufacturing on a contract starts with issuance of blueprints and bill of material sheets by engineering. When they reach the time study department, the corresponding daily records bearing advance loading are withdrawn from the file and checked against blueprints for specification changes which might affect the accuracy of advance loading. After necessary adjustments have been made to the machine loads, and standard time values applied as broadly as possible, prints and bills of material are routed to tooling and inspection departments

PRODUCTION CONTROL LOAD AND PROGRESS RECORD

	Order number, customer's name and description or order shown in first three spaces of lines numbered 1 to 20 below. Total hours loaded shown in machine group columns		MACHINE GROUP CODE	LL ML	SL	LP-MP PM	VBM BUL	HBM MM-HD	TL	RD
			GROUP NUMBER	1	2	3	4	5	6	7
1	X-1843-1939	Coastal Paper Co. 100" Cyl. Mach. Add		(24.1)	91.6	34.4	13.2	143.5	47.7	130.2
20										
	Starting with hours used to date, job progress shown by % completed in double lines of square space below—groups 1 through 11 in upper space; groups 12 and 13 in lower space		TOTAL LOAD							
			X							
			USED TO DATE	253.5	109.3	178.7	37.2	174.7	247.2	127.3
			TOTAL AHEAD			SEE "NET AHEAD" BELO				
			AVAILABLE HRS.	2810	700	1285	1055	1285	1065	700
			SUBCONTRACTED	—	—	NONE	—	—	—	—
			NET AHEAD		91.6	52.1	34.2	152.3	48.3	133.7
			WEEK ENDING USED			17.7	21.0	8.8	.6	3.5
			6-8-41 AHEAD		91.6	34.4	13.2	143.5	47.7	130.2

CONTRACT NUMBER

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTAL
68															68
33															33
72															72
34															34

FIGURE 1. PRODUCTION CONTROL LOAD AND PROGRESS RECORD. HERE USED AS PROGRESS RECORD. CONTAINS SUMMARY . . .

PRODUCTION CONTROL RECORD

DATE OF ORDER	ENG. STARTED	ENG. COMPLETED	PURCH. STARTED	PURCH. COMPLETED	MFG. STARTED	MFG. COMPLETED	DATE

MACHINE GROUP CODE	LL-ML	SL	LP-MP-PM	VBM-BUL	HBM-MM-HD	TL	RD	MGC	IGE	SG
GROUP NUMBER	1	2	3	4	5	6	7	8	9	10
TOTAL HOURS LOADED	12.0				.9	4.9	1.6			
TOTAL HOURS USED										

DATE	1	2	3	4	5	6	7	8	9	10	11	SUB	12	13	14	15	TOTAL
12/11	39					42						81	3	8			92
30							14					14		15			29
31	55											55		28			83
1/2	35											35				1-45	

DATE	1	2	3

ORDER NO	CUSTOMER	DESCRIPTION OF ORDER
X-1843	COASTAL PAPER CO.	22X94 CENT. CAST BZ. BRG

FIGURE 2. PRODUCTION CONTROL RECORD CARRIES DAILY POSTING OF HOURS USED FOR INDIVIDUAL CONTRACT ORDERS. . .

for checking against requirements pertinent to these functions, then returned to time study for final processing. Standard time values are typed on prints, any loading changes are made on a buff copy of the weekly summary, and all loaded hours summarized for addition to the weekly load chart.

Progress reporting. This function is carried out by a time study clerk. It is a weekly statement of contract hours remaining. Reports are made on the load and progress record, translucent for ease of duplication (see Figure 1). Space is provided (upper half) for listing 20 contracts by order number range, customer, brief description, and hours loaded or hours ahead by groups.

Before progress reporting is begun, an entry is made on each monthly copy showing total-hours-loaded. These totals appear on the line designated "Total Load" (top of lower half of form). In instances where contracts have been loaded from very old data or wholly from standard time allowances, it has been found advisable to increase total load figures by an arbitrary correction factor (line X), usually not exceeding 10 or 15 per cent.

The load record is distributed to interested departments on a

IGC	SG	RG	SUB-TOTAL	MISC.	ASS'Y	PATT.	EXC.	GRAND TOTAL	SALES HOURS ESTIMATE
9	10	11		12	13	14	15		
34.5	7.2	.5	502.8	82.3	913.0			1498.1	3305
	13.7	7.3	1148.9	57.2	459.2			1665.3	
230	115	365	9600	800	5600			1600.0	
34.5	7.2	.5	554.4	82.8	920.8			1558.0	
			51.6	.5	7.8			59.9	
34.5	7.2	.5	502.8	82.3	913.0			1498.1	

. . . POSTING OF HOURS LOADED AND USED FOR ONE MONTH'S SCHEDULE OF CONTRACTS

CUSTOMER	ORDER NO.
COASTAL PAPER CO.	X-1843

SUB-TOTAL	MISC.	ASS'Y	PATT.	EXC.	GRAND TOTAL	SALES HOURS ESTIMATE
	12	13	14	15		
26.9	.5	7.6			35.0	
						37.0

5	6	7	8	9	10	11	SUB	12	13	14	15	TOTAL

	WEEK LOADED	PROMISED SHIPPING DATE
T ROLL	10-22-46	7-47

. . . WITH TOTAL HOURS LOADED IN EACH MACHINE GROUP APPEARING AT TOP

monthly basis to keep them abreast of schedule changes and to serve as a convenient reference for total contract loads by months. When the form is used for reporting progress of monthly schedules, it is concerned only with hours used and hours ahead.

The difference between the total hours used transferred from the white copy, and the total-loaded-hours transferred from buff copy of the weekly summary are the hours ahead for the contract. In those instances where hours used are greater than hours loaded, the difference is shown on the load and progress record as a minus figure, and is circled for further emphasis. The group totals of all positive hours-ahead at the start of any given month are shown on the line designated as "total ahead." Negative hours are disregarded in adding hours-ahead by groups, since their inclusion would distort the true hours-ahead figures.

Hours used to date are shown for reference on the line so designated and are for the week ending immediately prior to the date the record is originated.

"Available hours" are determined arbitrarily by the production control department and are dependent upon such factors as the length of the work week, number of employees, activity of the repair business, and the number of work shifts. This line of figures appears unchanged from week to week as long as the conditions governing them remain constant.

Subcontracted hours are deducted from the loaded hours on the weekly summary record and consequently are seldom entered on the progress record. When no subcontract hours are shown, the "net ahead" figures are the same as the total ahead figures appearing three lines above.

Per Cent Complete Reported

Week-by-week progress reports of hours used and ahead are shown in the double lines following and are identified by the space for a "week ending" date. To the left of this date and under numbers 1 through 15, corresponding to the numbered lines of contract listings above, are shown figures indicating job progress by per cent completed. The upper per cent figure shows machinery progress of groups 1 through 11; the lower figures show progress of miscellaneous and assembly time represented by groups 12 and 13.

For the same reason that negative hours appear in contract progress reporting, it is a common occurrence for a job to be completed in less than loaded time. Consequently, as a contract nears completion, its theoretical status as indicated by the difference between loaded and used hours is compared with its actual status through a physical check obtained from the production control office. As soon as a contract is found to be essentially completed a notation is made on the record. In this way, residual hours ahead or negative (excessive) hours are dropped from the record before they become a source of misleading information.

CASES IN WORK SIMPLIFICATION

Too small to have a methods improvement specialist. So this 100-man plant made every employee a methods man. Examples shown here were selected by a FACTORY field editor with the assistance of T. E. Rassieur, president

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HANDLING costs are down about 60 per cent. Processing improvements account for another 25 per cent saving. And about 20 per cent of plant floor area has been released for new uses.

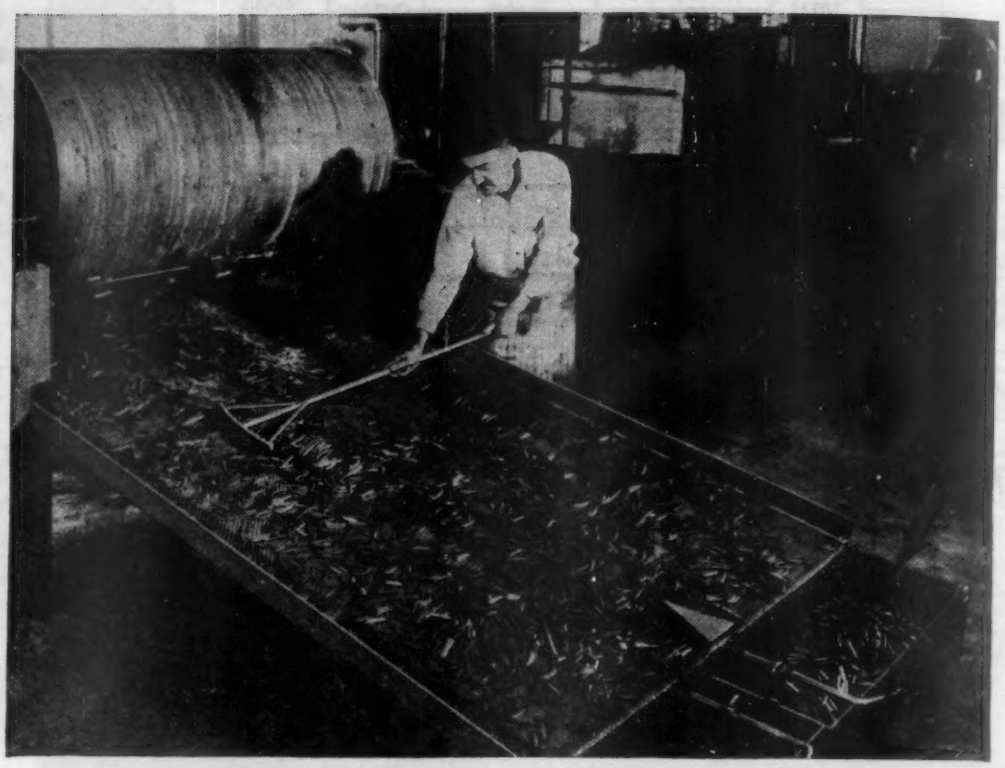
An over-all picture of the methods improvement program and its results looks something like the above. Savings made in handling, processing, and storing will pay for this St. Louis company's new plant and most of the equipment within the next twelve to fifteen years.

Primary products include blast-hole drilling equipment for the mining of coal, salt, potash, gypsum, and other metallic and non-metallic ores. The company occupies a new plant with 42,000 square feet of floor area.

Except in a very few cases, all new and improved methods come direct from production supervision and the workers. Some of them stem in the idea stage from top management, but are passed on to the production group as suggestions only.

In some plants it is only during hard times that pressure is applied to economize and find better methods to reduce costs. Here the pressure is on all the time. The company is small and flexible. And that fact, perhaps, permits it to do things more quickly and with a minimum of red tape. It doesn't matter if an operation was improved yesterday. The company will improve it again the next day if it can find a better way.

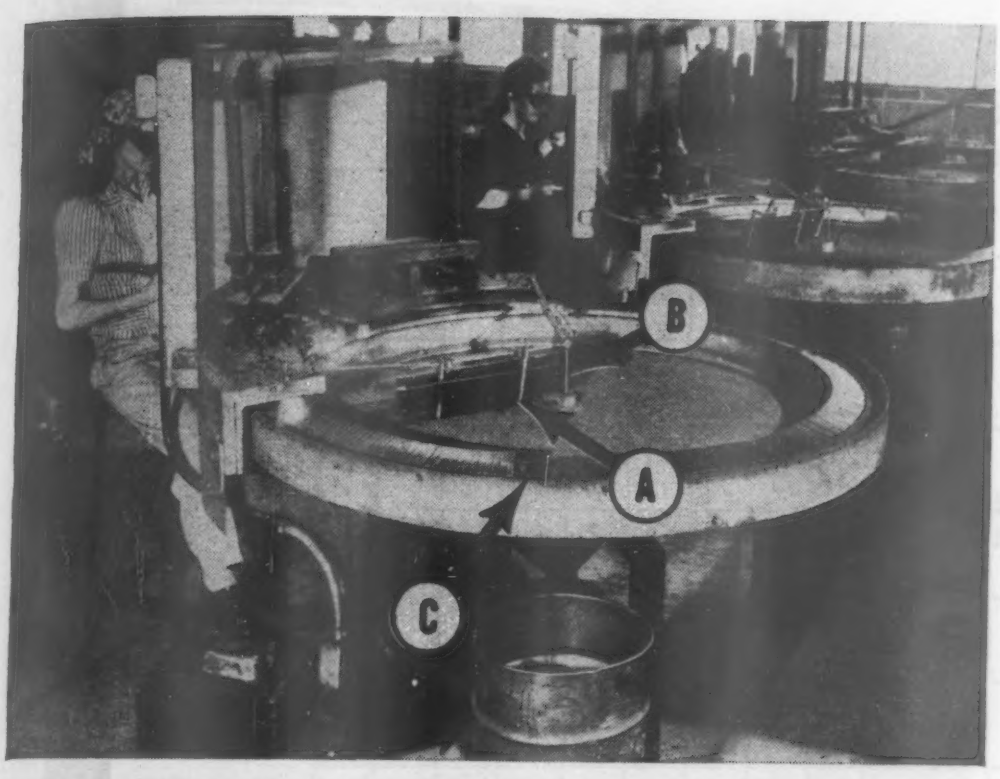
To take a closer look at some of the improvements made with their resulting saving, FACTORY picked the examples illustrated on these pages.



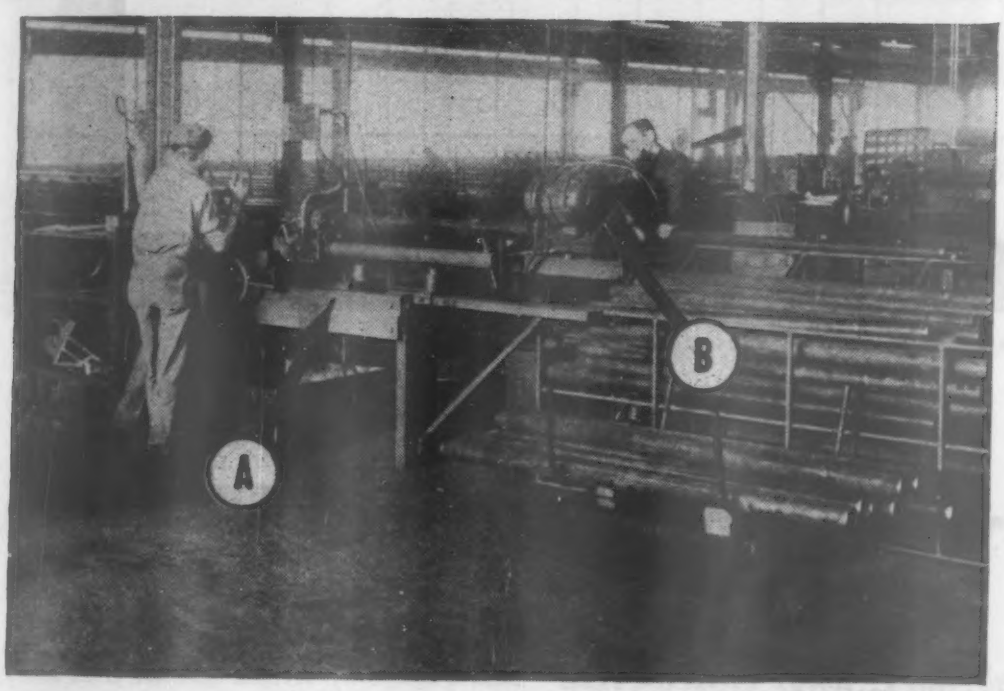
1. DRILL BITS DE-BURRED in tumbler (background) were formerly dumped into metal containers and hand-cleaned of compound used in tumbler. Bits now drop directly from tumbler onto vibrating shake-off screen and compound falls through automatically. Worker then rakes bits into specially designed toteboxes (arrow). When filled, toteboxes are picked up with crane attachment on handling truck and moved direct to packing department. RESULTS—cleaning time cut 40 per cent; handling time reduced; product quality improved.

2. PACKAGING OF DRILL BITS was formerly done in an awkward and cumbersome way. Metal containers were lifted on benches and workers had to pick bits out. Now, with crane attachment to handling truck, a full totebox can be picked up and dumped into one of six hoppers designed for special packaging bench. Rakes (arrow) are used to pull a quantity of bits into convenient working position. RESULTS—everything within normal reach of worker; packaging time reduced more than 50 per cent; handling between production operations greatly simplified.

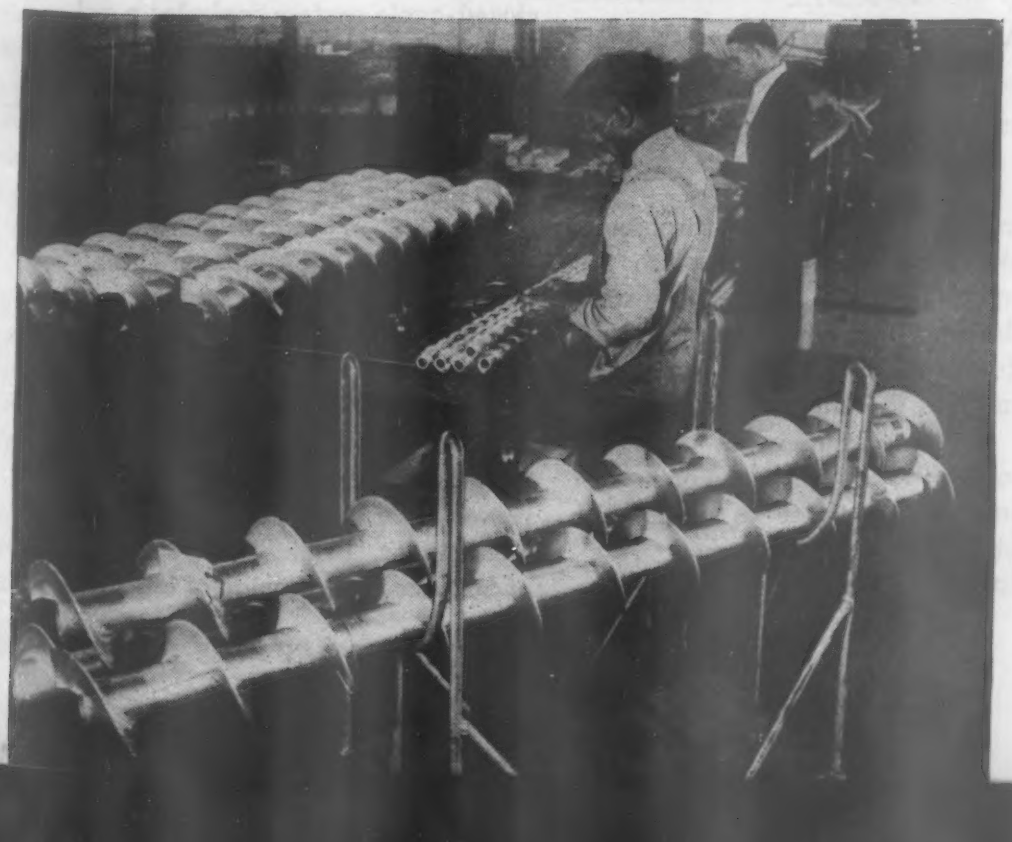
6. Central Mine Equipment Company



3. HARD-SURFACING TABLE that rotates is really paying big dividends. Before, drill bits were lined up in straight rows on metal-surfaced bench and then hard-surfaced. Now operation has been made as nearly automatic as possible. Table speed is controlled by foot lever. Gas flames at operator's left prewarm bits; flames at right cool bits after hard-surfacing. Mirrors (*A* and *B*) are mounted so worker can watch flames. With mirrors worker can "tell at a glance" whether flames are adjusted correctly. Hole in table (*C*) drops hot bits into metal container. RESULTS—production increased over 100 per cent; bench space saved; product quality improved.



4. SPECIAL RACK for feeding materials in process from one operation to another makes work easier. Before, tubes, bars, and rods were piled on flat trucks located adjacent to cutoff saw (*A*), and then either pulled or pushed to chamfering machine (*B*). Rack makes it easy for worker merely to slide material down incline of rack to other operator. RESULTS—floor space saved by eliminating flat trucks; time saved on part of each worker will exceed 25 per cent through elimination of turning and stooping; between-operation handling completely eliminated.



5. SPECIAL HANDLING TRUCK for augers was developed as part of recent materials handling improvement campaign. Before, they were piled haphazardly on flat materials handling trucks. This was dangerous. Also, truck was awkward to handle because of various auger lengths. Now a completed load can be moved throughout various manufacturing processes quickly, easily, safely. RESULTS—floor space saved, approximately 30 per cent; work elevated to within easy reaching distance of the worker; safety hazards completely eliminated.

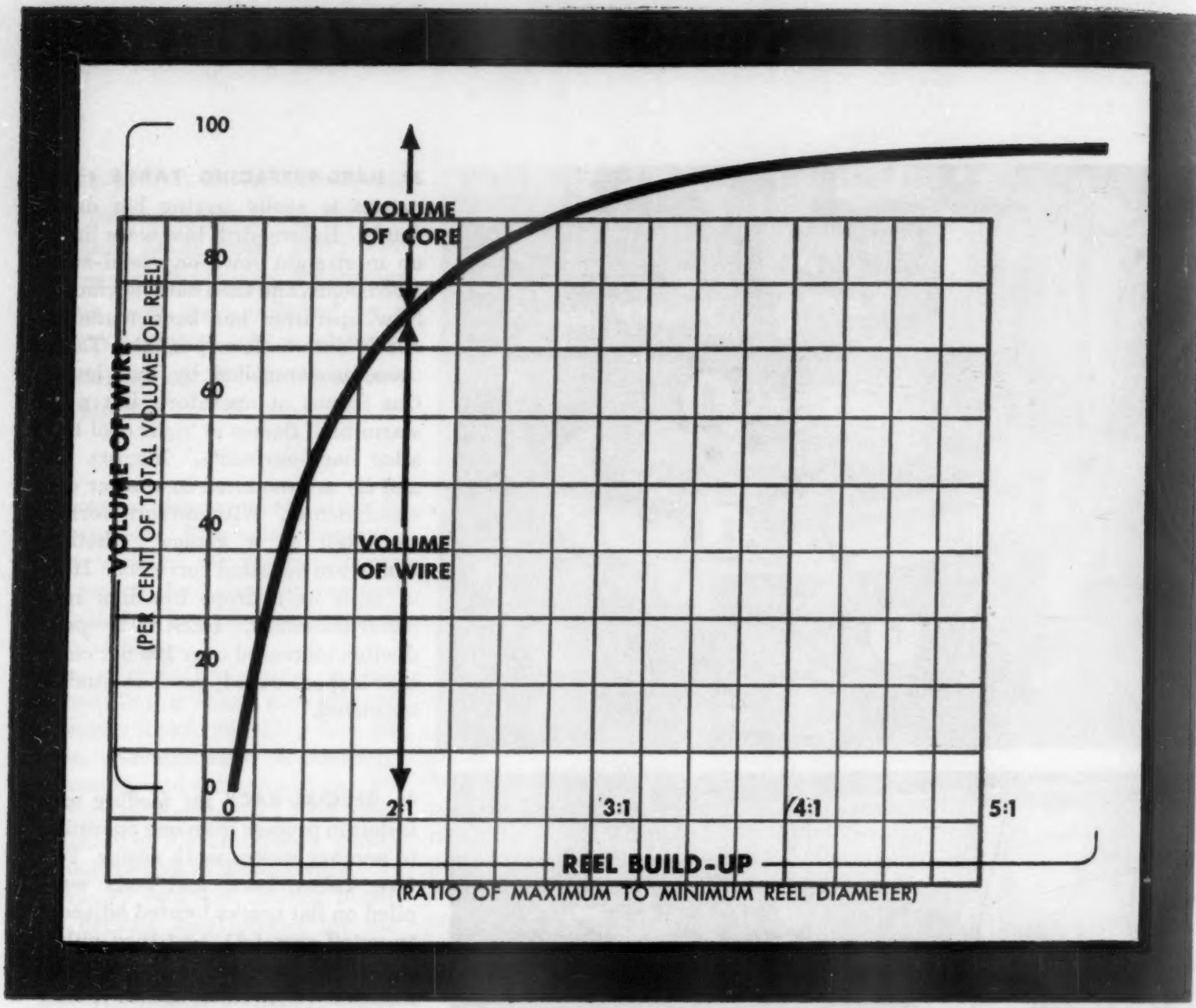


FIGURE 1. ON A REEL, BUILD-UP GREATER THAN ABOUT 3 TO 1 ADDS COMPARATIVELY LITTLE TO THE VOLUME OF MATERIAL

CLOSED-CYCLE MOTOR CONTROL:

The last of three articles. In February, what closed-cycle motor control is; in March, where it is used

B. COOPER • CONTROL ENGINEERING DIVISION, GENERAL ELECTRIC COMPANY SCHENECTADY

PRECEDING articles in the February and March issues described closed-cycle motor control systems. The various functional components of the system were discussed, and a number of typical applications were described. No emphasis was placed on the application problems involved, however, or on how the solutions to these problems are effected. This article will highlight some of these application problems.

With a closed-cycle system the primary problem is that of system stability. This problem is somewhat different from those normally encountered in control work. Usually it requires somewhat different thinking in the application of control principles, in order to obtain the best system performance.

In the first article (February issue, Figure 1) it was shown that a closed-cycle system includes a reference element, or the standard; a feedback element that measures the system operating conditions; a control element that compares the feedback with the standard and provides the "brain" or control senses; and the power or actuating elements.

With closed-cycle control, top system performance demands top performance from each element in the system. A sluggish, inaccurate control element will destroy performance as readily as inadequate power elements. The best control element, or "brain," is one capable of fast, accurate sensing of true con-

FIGURE 2. WITH A DANCER ROLL, STORAGE IS TWICE DEPTH OF LOOP

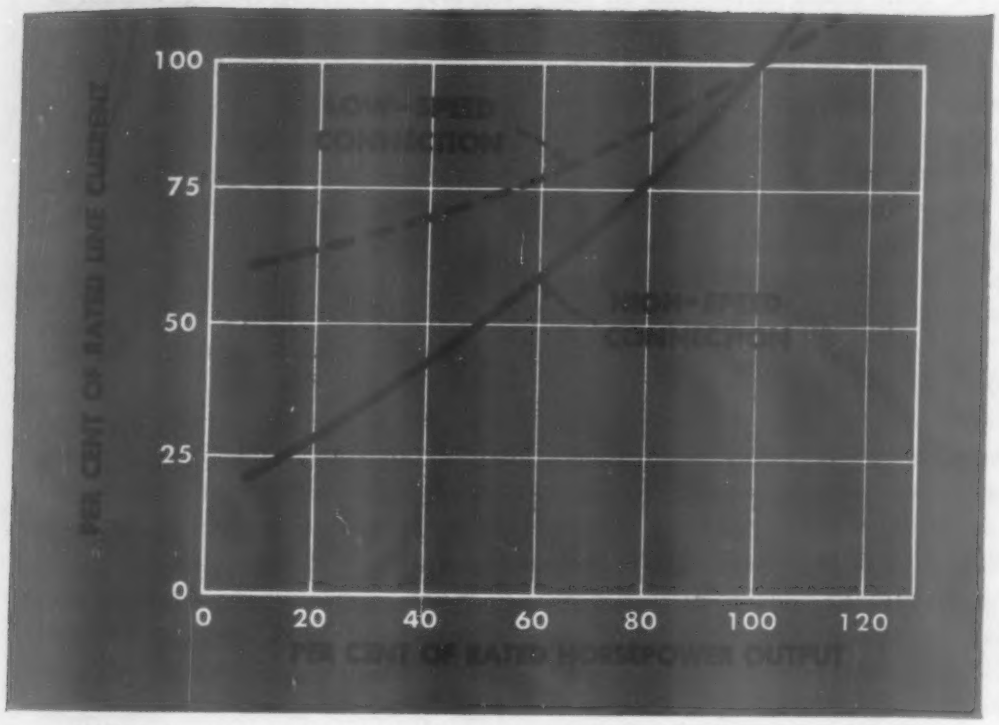


FIGURE 3. LOAD-CURRENT CURVES OF TWO-SPEED INDUCTION MOTORS

APPLICATION PROBLEMS

ditions, and equally fast and accurate reduction of this evidence to directions for action. Time delays, either in recognizing operating conditions or in defining corrective action, detract from the performance and may lead to system instability or hunting.

Hunting is an undesirable operating condition in which the system continuously oscillates about the selected operating point without settling down. The system is always overshooting the mark.

The constant overshooting is the result of system time delays that cause the control to respond so slowly, either in the application or the removal of the accelerating force, that the desired condition is passed before the system can readjust itself.

All time delays are not confined to the control brain itself; they are spread throughout the system. They are made up of electrical time constants caused by the inductance of magnetic circuits or capacitors in which energy must be stored and released; mechanical time constants resulting from motor and machine inertias; and sometimes of transportation time or other delays due to the system arrangement. Together, all these form in the system the delays that must be dealt with.

For the most successful applications, it is necessary that all who attempt to use or apply closed-cycle control be aware of the undesirable effects of system time constants. Also, that they do everything possible to reduce or eliminate them.

To overcome the undesirable effects of these time constants and insure system stability, electrical designers may utilize neutralizing elements consisting of lead and lag networks that serve to provide anticipatory senses and to modify the response to suit a particular application. Controls frequently are provided so that these networks may be adjusted in order to obtain optimum performance.

Although the values of the constants in these neutralizing networks may be calculated, in general the lack of reliable system data and the cumbersomeness of many calculations result in leaving the final selection of stability constants to be done on the job with the equipment at hand.

Other control techniques frequently used are system forcing, which provides high accelerating forces to overcome system inertias more quickly, and degeneration, which modifies the system time constants and greatly improves system stability.

Designers also must strive to reduce the system time constants represented by the inertias of connected apparatus and by the weights or volumes of other mechanical, hydraulic, or pneumatic equipment. Usually this is done by minimizing the weights of moving parts, selecting proper gear ratios, and providing a well-co-ordinated mechanical system with as few moving parts as possible.

This is an important matter to all who utilize this type of control, because it is not uncommon for the user to build an appreciable part of the system. At the least, he must specify what is needed, and the greater his understanding of the factors involved, the more successful will be his over-all results.

Speed Control

Speed control applications commonly are made to utilize the wide range of adjustable speed control provided by the closed-cycle system.

At very low speeds there is sometimes the problem of obtaining uniform armature rotation. It is solved in the design of the motor by a number of methods, one of which is the skewing of the armature stacking to minimize any tendency of the motor to lock-in at slot positions.

For wide speed ranges it is important that the speed of response be fast and accurate. The high response rate is needed to handle any rapid load changes and to provide the snappy, accurate jogging, inching, or positioning that is most frequently accomplished at the lower speeds. To obtain rapid response without excessive overshoot at low speeds is the most difficult problem.

When operating at 5 per cent of base speed, the no-load armature voltage may be on the order of 12 to 15 volts, but to supply full-load torque may require 35 to 40 volts armature voltage. The control system obviously must be fast and accurate to change the armature voltage automatically, so as to maintain speed. Any error in failing to apply the correct armature voltage is greatly magnified since the counter-emf., which is a measure of speed, is only 11 to 12 volts, whereas the voltage necessary to overcome the *IR* drop may be from 20 to 30 volts. An error of only 2 or 3 volts, expressed as a percentage of the counter-emf., represents a 20 to 25 per cent speed error. Therefore satisfactory performance over wide ranges of armature voltage control will be limited by the load conditions encountered.

For steady loads, where the control will have plenty of time to function, a wide range of control is feasible. As much as an 80:1 range of speed by armature voltage control has been obtained for uniform load applications. On the other hand, it has been difficult at times to satisfy other applications where only 20:1 range of control is needed. For general-purpose applications, a 20:1 limit of speed control by armature voltage commonly is used as a working figure. Any recommendations beyond this point are made only after careful consideration of the particular application.

The upper range of the speed control is determined by motor field weakening, which commonly is used to obtain as much as 4:1 range of speed control. As the field is weakened, the torque-producing ability of the motor is reduced because the torque per ampere of armature current is directly dependent on the field strength. This decrease in available torque, plus the fact that more rotational energy will be stored in the rotating parts moving at higher speeds, limits the speed of response at reduced field.

Since the control element acts to correct system errors, it must be recognized that shock loads may cause temporary deviations of speed larger than those calculated on the basis of the steady-state accuracy of the system. In general, these temporary deviations will be determined by the inherent regulation of the power elements and the inertia of the system. At the extreme, they should not temporarily exceed the normal regulation of the system without the closed-cycle correction.

Temperature effects must be considered if either absolute or relative speeds are to be maintained. For uncompensated armature-voltage-control systems, temperature effects may change the operating speeds from 4 to 8 per cent, due to the change of field resistance with normal motor heating. Field-voltage control systems are even more temperature-sensitive, experiencing as much as a 15 per cent change due to field heating.

For those applications where variations in operating speed due to temperature cannot be tolerated, care must be taken to specify that either a tachometer feedback system be used, or that field current is to be regulated. In general, the tachometer feedback systems are somewhat more expensive, but they will provide a higher degree of accuracy.

Reeling Drives

In any reeling drive, the first fact to be recognized is that the reel drive itself is but part of some larger system, and that all performance characteristics must be related to the complete system. The reel control must supply not only the proper tension in the material being wound onto the reel, but it must be capable of accelerating and decelerating with the associated equipment.

A second consideration is the accuracy with which tension must be held. If tension is extremely important, there is no substitute for a tension-measuring device as the signaling or feedback element. The simplest of these measuring devices is a weighted dancer roll coupled to an electrical signaling device such as a solenoid.

To ease the stability problem and provide storage for acceleration and deceleration periods, the length of the loop must always be considered.

The following rule of thumb frequently has been used to determine the amount of storage (Figure 2) in the loop: The loop storage should be 1 foot plus 1 foot for each 200 f.p.m. of operating speed to cover the normal control range, plus an additional 20 per cent to provide proper force action at the extremes. Expressed by formula, this becomes:

$$\text{Storage in feet} = \frac{(1 + F.p.m.) \times 1.2}{200}$$

This formula does not take into consideration the inertia of the system or the rate of acceleration, which obviously affect the performance. High-inertia or rapid-accelerating systems may require more storage than indicated.

When approximate tension systems are utilized, such as the one based on holding constant-horsepower input, great care must be taken to eliminate as much friction as possible from the drive. Any torque used to overcome friction tends to introduce errors in the tension being held. Compensating circuits are used to overcome these disadvantages, but at best they can only approximate constant tension on the basis that this system will exhibit certain predictable characteristics.

Inertia compensation becomes essential to supply automatically sufficient horsepower during periods of changing speed, not only to hold tension but also to provide the accelerating or decelerating forces necessary to overcome the inertias of the system. The big advantage offered by the constant-horsepower systems is the simplification of the mechanical arrangement and elimination of dancer rolls or other tension-measuring apparatus. These constant-horsepower systems perform very well when carefully applied, but it must always be

remembered that they represent only an approximating method.

Another factor deserving of important consideration is the design of the reel itself. Here much can be done to simplify the control problem and provide adequate control apparatus more economically. When one examines the curve in Figure 1 and is aware of the difficulties and expense involved in perfecting wide field-range controls, it becomes rather difficult to justify the large reel build-up ratios on the basis of reel efficiency.

This curve is calculated on the basis of a fixed outside reel diameter, which is determined by the maximum permissible material speed and/or limitations of the reel handling equipment. For 3-to-1 build-up, 89 per cent of the reel volume is active material, and by decreasing the core diameter to get a 4-to-1 build-up, only another 4 or 5 per cent is added to the volume of the material. Obviously, the law of diminishing returns has set in.

Automatic Load Control

Another natural application is automatic load control systems. Here the principal problem is to obtain a simple, inexpensive measure of the load to be controlled.

With a.c. induction motors, the line current frequently is used as a measure of load. This can be done quite successfully if the motor characteristics are suitable. Typical load- current characteristics of a two-speed induction motor are given in Figure 3. With the high-speed connection, line current may be used to indicate load conditions, but the low-speed connection characteristic is unsuitable for load indication purposes because of the small change in line current with load.

Stability considerations are always particularly important on this type of application. All system time lags must be carefully considered, because they may be an important factor in the choice of the control system. For example, if the closed-cycle system includes a conveyor that is carrying material to a grinder, there may be considerable time lag between the instant when the conveyor speed is changed and when the load on the grinder motor changes. This may be due to transportation lag, or the time of transit of the material to the grinder. Or it may be due to the large capacity of the grinder, which may require considerable time to fill. In either case, it is frequently desirable to use a relatively slow control system of an integrating nature that controls the rate at which the conveyor speed is changed.

Upon recognition of unsatisfactory load conditions this type of control merely starts increasing or decreasing the speed as needed to restore load conditions to normal. No immediate speed change is made by an integrating control; only a rate of correction is determined. This type of control, although slow in response, may prove most satisfactory because it eliminates rapid speed changes and allows the remainder of the system to catch up. It also tends to iron out sudden load peaks caused by a momentary oversupply of unground material, and thus produces a smoother operating system.

Applications are not limited to integrating or derivative controls: direct or proportional controls are used where system time lags are small.

Closed-cycle motor control is a versatile tool, whose advantages are not always fully realized because of its relative newness. However, from the standpoint of increased over-all efficiency and greater production, this tool is one that industry can hardly afford to overlook. The types of jobs that it can accomplish are many and, in general, are limited only by failure to appreciate what can be accomplished.

WHAT ELECTRONIC CLOSED-CYCLE MOTOR CONTROL DOES

1. Offers more accurate control, which results in better machine performance.

2. Provides stepless adjustment of speed or other control variable over wide ranges of operation. This insures the selection of the optimum operating conditions.

3. Allows good speed of response to be obtained or matched with other machine characteristics, provided they are within the capabilities of motors and associated equipment.

4. Lends itself to automatic machine cycles, and is extremely versatile where selection of many pre-set speeds or other operating conditions is desired.

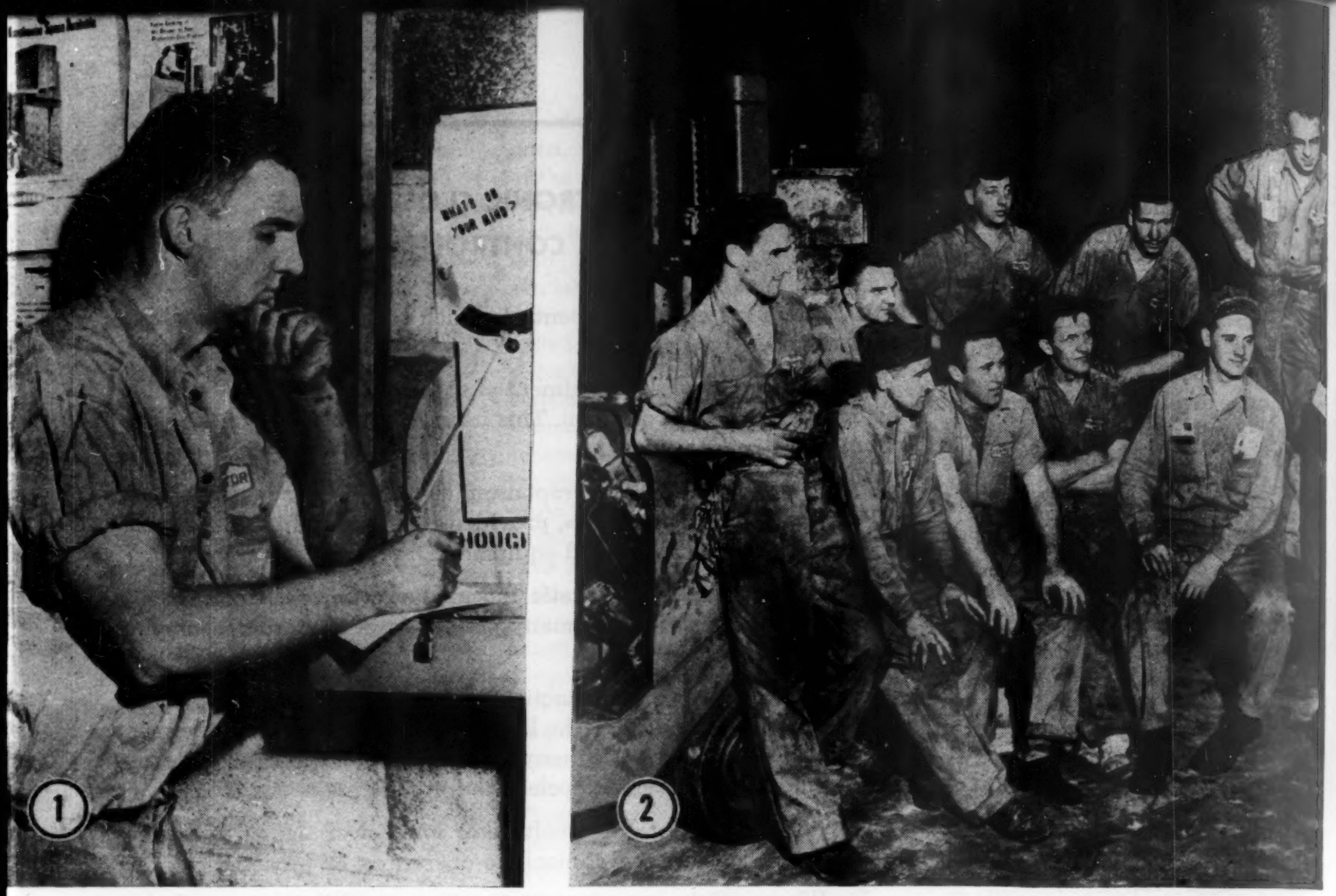
5. Blends two or more functions together automatically. For example, torque can be made the limiting function when it is the most important variable, or speed may be the controlling function at some other point in the machine cycle where it is of major importance.

6. Allows the use of low-voltage or low-power signals with electronic amplifiers to control machine operations or processes.

7. Where efficiency is important, offers one of the most efficient adjustable-speed drives for a wide range of speed control.

8. Requires low maintenance.

9. Offers a degree of reliability even higher than that of many conventional equipments using mechanical devices to achieve equivalent results.



TOWMOTER PROVIDES THREE WAYS to get company information to employees. . . 1. Any employee may ask any question, get answer in talk over loudspeaker system. . . 2. Each foreman holds regular meetings with small groups in his section; if he can't

INFORMATION-SHARING COMES FIRST

Simple, successful personnel program is based on policy of telling employees everything they need to know

CHARLES R. SCHUBERT • FIELD EDITOR, *FACTORY*, CLEVELAND

TWENTY-EIGHT years of continuous, uninterrupted pay checks, and labor turnover caused by voluntary separation of only 0.6 per cent per month. That's the record of the Towmotor Corporation, Cleveland. No magic formula has produced these results. Hard work on the part of Towmotor's management and sales force has meant that no employee ever lost a day's pay because of lack of work or shortage of material. And good personnel relations—the result of level heads and a lot more hard work—have added up to a complete absence of time lost because of labor disputes.

Three types of activity assure that employees not only are given all the information that they desire, but also that they understand the necessity and the reasons for even those policies with which they may not wholeheartedly agree. These activities are: Formal information-sharing programs, foremen's meetings with their men, and group meetings of men with top management.

Formal programs. Any employee may request information on any subject concerning the company, its affairs, its policies, or his relation to them. Boxes where questions and requests for information may be deposited are located at each bulletin board.

Sometimes the boxes are used by employees merely to give expression to their pet gripes; but not infrequently the requests for information are carefully thought-out statements which incorporate constructive suggestions. All questions, no matter how trivial they might seem at the time, are sifted by a management committee, and filed under various topic heads. When enough questions have been received to warrant a formal talk on any particular phase of the operation, the executive charged with the particular activity is requested to prepare a talk covering the entire range of the questions in the file. The talk is then scheduled for presentation over the plant intercommunication system. It is always delivered by the executive who prepared it, and all plant operations are suspended while it is being delivered. To date, these talks have covered the entire gamut from the

answer a question, it is his job to find someone who can and then relay information. . . 3. Groups of about 20 men from same department meet with a top management group, composed of executive vice-president, factory manager, the personnel director

IN HUMAN RELATIONS HERE

company's labor policy to quality inspection and the problem of servicing in the field.

Foremen's meetings. At frequent intervals foremen hold meetings of small groups of their men (usually 10 to 15) and talk with them on subjects pertaining specifically to operations of their departments. While general outlines of such subjects are furnished a foremen on request, management prefers that he prepare the talk himself. The foreman must answer any question that any member of the group may see fit to raise. And it is understood by every foreman that if he does not know the answer to a question, it is his job to find it out and pass the information on to the questioner.

In addition to furnishing practical information on timely subjects to the men, these meetings serve to educate the foremen by keeping them abreast of current technical developments.

Each foreman is required to know his men as intimately as possible, and these informal meetings serve to promote that relationship. They also help to give the foreman a better idea of the abilities, shortcomings, and potentialities of his men.

Group meetings with management. Groups of about 20 men, usually from the same department, are periodically given an opportunity to meet with a management group composed of the executive vice-president, the factory manager, and the personnel director. At these meetings, all are encouraged to talk out on any subjects pertaining to general plant operation in which they either have a particular interest or a gripe. Frequently, a man gives voice to dissatisfactions with his supervision or working conditions that he would not discuss with his foreman. Just as frequently his fellow-employees speak up in defense of the points with which he has expressed dissatisfaction. This lack of support often results in the man realizing and admitting that perhaps he is being too finicky. On the other hand, these sessions sometimes reveal foremen's weaknesses which are not apparent to the men themselves or to management.

These meetings with management, however, are not intended to, and do not, operate simply as gripe sessions. More often the topic of discussion will be a projected new layout, how to improve materials handling, or some other problem related to operational efficiency of the department the men represent.

Secondary Channels

No successful program of personnel relations can be built exclu-

sively upon the three-part program outlined above, or, for that matter, on any "fixed" program, formal or informal. In the final analysis, it is the intangibles that determine the success or failure of a personnel program. But there are certain other tangible activities engaged in at Towmotor which make it easier for that elusive team spirit or pride-of-job to bridge the final gap.

Free aid and advice. Many problems of a purely personal nature reduce an employee's attention to his job. Among these may be income tax problems, housing, purchase of property, insurance claims, family sickness, or many others. There are men in the plant who daily earn their salary solving these or similar problems for the company. The services of these men are made available free to anyone in the organization who is in need of such advice. This sort of "personal" information saves the employee much worry and expense, and is felt to contribute to the company's fine absentee record, by eliminating much of the need for employees to remain off the job to solve these problems.

Open house meetings. As a result of a great many requests from employees to let their families and friends see the plant and its activities, it was decided to throw the plant open for this purpose four times a year. Conducted on a completely informal basis, these open house programs have done a great deal to solidify and extend the feeling of friendship and mutual interest between Towmotor and the families of its employees.

Disciplinary action. Theft, drinking on the job, threatening or coercing fellow-workers, destruction of property, or outright insubordination are, of course, cause for immediate dismissal. For minor offenses, a program has been worked out which guarantees the employee against possible prejudice on the part of his supervisor. If an offense is repeated after a warning from the supervisor, the matter is taken up with the personnel director.

At this stage, an exhaustive attempt is made to discover the underlying causes of the breach (if other than admitted negligence). If, on the basis of this study, it appears that the man would have a better chance for success on another job (either because of lack of capability or because of a clash of personalities), he is offered the opportunity to transfer to a different job under a different foreman. If he succeeds, the record is wiped clean, and the new job is looked upon as a fresh start.

Re-study of job. Each man's daily task is set by actual time study of the job. However, if a man feels that the task which has been assigned to him is greater than he should be expected to perform, he can obtain an immediate re-study of the job by the time study department by simply asking the foreman. If the re-check shows that the original figure was in error, it is immediately re-established at a lower figure. But if the task rate is upheld, and the employee still feels that it is too high, he may have a more experienced employee assigned to work with him. It is this man's job to show him, first, that it is possible to meet the given task by actually doing so, and, second, to help him accomplish it by observing him on the job and correcting the flaws in his technique.

Re-evaluation of job. All pay is on a straight day rate based on the job evaluation point assigned to the particular job. All pay raises and promotions are based entirely on merit. If a man feels the rate established for his job is too low, he may ask for and receive a re-evaluation of his task. In this case, the job evaluation factor would be re-checked to make sure that additional factors had not been added to the original check, or that the emphasis had not changed on those already accounted for. If the man feels that he has not received as many merit increases as he is entitled to, he may request the personnel office to review his merit record (submitted monthly by his foreman) with a view to eliminating possible errors or inequities. After the review has been made, the decision of the personnel director is, of course, final and must be accepted.

Safety. The safety committee in the shop is made up entirely of hourly paid employees. Foremen and other plant executives who qualify as "experts" in particular fields of safety are occasionally invited to attend meetings, and may be requested to express their opinion on the particular matter under discussion. Since the men themselves are responsible for the safety of the shop, they take a deep-seated interest in seeing that all sound safety precautions are taken.

Promotion from within. Promotion to jobs of higher responsibility in the organization is made from the rank of present employees wherever possible. Every employee is guaranteed that so long as there is a man in the plant who has the qualifications required to fill an open position, it will not be filled by anyone brought in from the outside.

Towmotor management knows that none of these policies is unique. But it does know that they are the tangible foundation stones of a workable industrial relations policy.

★ ★ ★ ★ ★ ★ ★ ★ ★

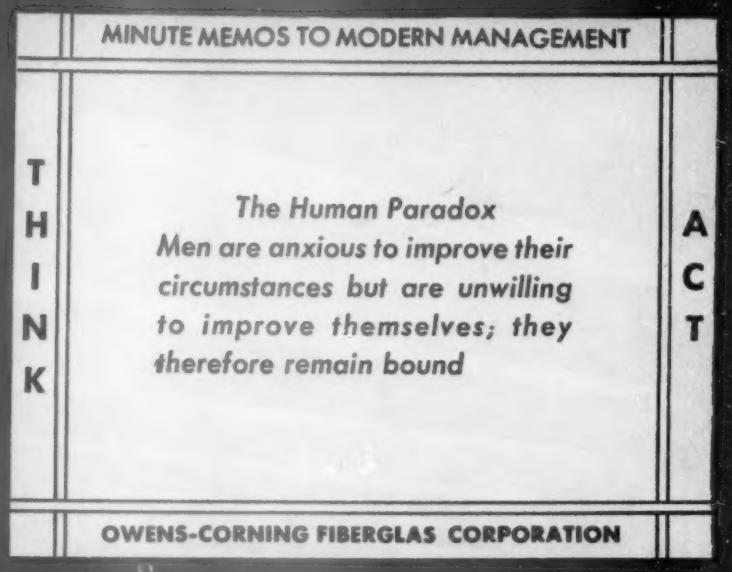
THE AMERICAN WAY

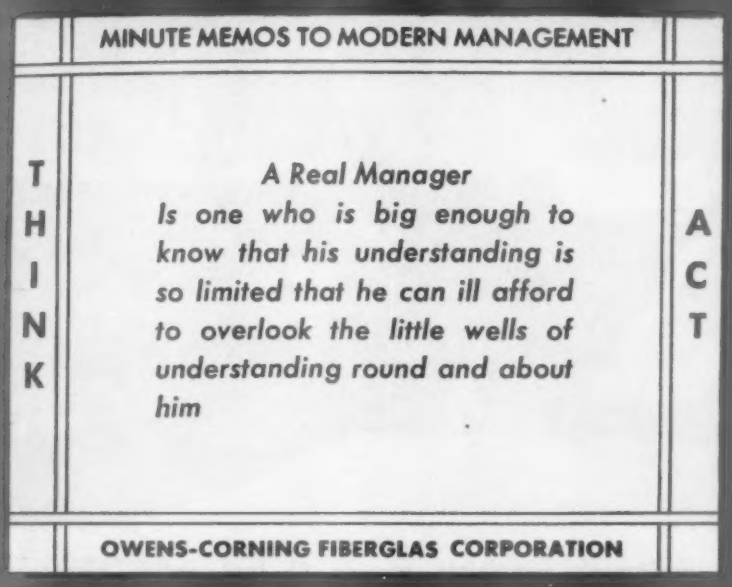
The phenomenal growth of American industry and the accompanying improvement in our standard of living is the result of one of the most powerful chain reactions in economics—i.e., from the technological improvement to lower costs—from lower costs to wider markets—from wider markets to mass production—from mass production to still lower costs, and from lower costs to still wider markets. Our economic history is replete with examples of this process.

Murray Shields, *Vice-President, Bank of the Manhattan Company, speaking to the American Gas Association and Edison Electric Institute*

★ ★ ★ ★ ★ ★ ★ ★ ★

MINUTE MEMOS TO MODERN MANAGEMENT
THINK
A man never has a job. He is always earning it
ACT
OWENS-CORNING FIBERGLAS CORPORATION


MINUTE MEMOS TO MODERN MANAGEMENT
THINK
The Human Paradox
Men are anxious to improve their circumstances but are unwilling to improve themselves; they therefore remain bound
ACT
OWENS-CORNING FIBERGLAS CORPORATION


MINUTE MEMOS TO MODERN MANAGEMENT
THINK
A Real Manager
Is one who is big enough to know that his understanding is so limited that he can ill afford to overlook the little wells of understanding round and about him
ACT
OWENS-CORNING FIBERGLAS CORPORATION

"THOUGHT FOR TODAY" STIMULATES SUPERVISORS' THINKING

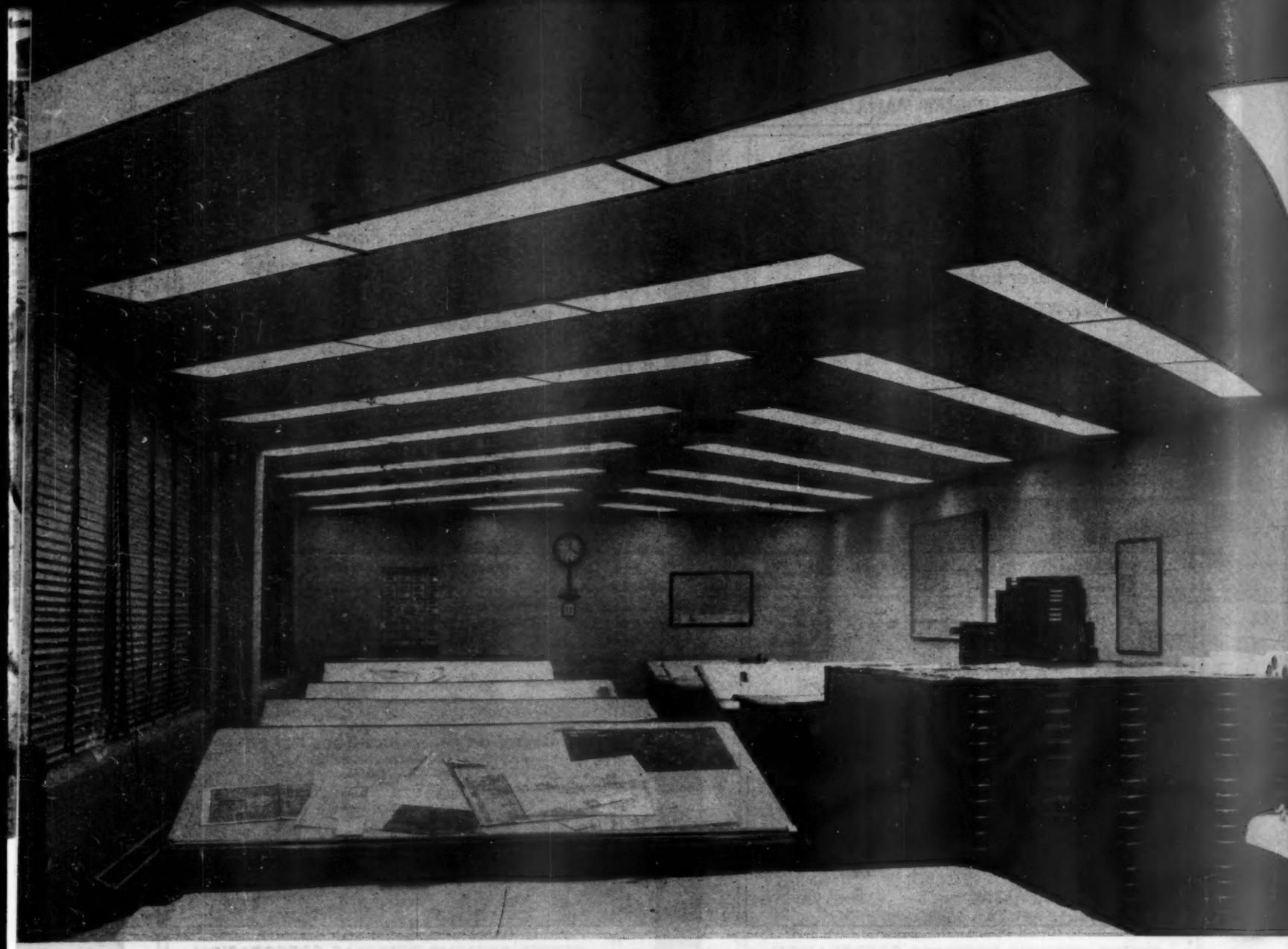
CLOYD S. STEINMETZ • DIRECTOR OF TRAINING, FIBERGLAS CORPORATION NEWARK, OHIO

As a supplement to its management development program, Fiberglas presents small cards to all supervisors, containing a "thought for today." They are known as "Minute Memos to Modern Management."

Each supervisor from group leader to plant manager has a small wooden holder. Once a day, every day, a new memo is placed in it. Subjects deal with any current item or message that the plant manager feels would be of interest to his management family. It may deal with production. It may carry his appeal for cooperation in safety, good housekeeping, or quality. Or it may be a general inspirational message.

Each morning as the plant manager makes his rounds, he stops and asks a supervisor, "What is the Minute Memo for today?"

If the gist of the memo for that particular day can be stated clearly, he presents the supervisor with a silver dollar. If the first man tackled does not know the answer, the manager continues to ask the supervisors, until he finds one who does. Not only do the silver dollars create comments; they also assure that attention is given to the Minute Memos.



PLANT ENGINEERING DEPARTMENT. Enclosed troffer units licked annoying dust problem, stopped drop in intensity, ended draftsmen's complaints, provide 85 foot-candles. Herringbone eliminates shadows on drawing boards

BETTER LIGHT IN DRAFTING ROOM

Second of two installations (first was described in March) that won prizes in a recent lighting competition

ENCLOSED troffer units proved to be the best answer when American Coating Mills, Inc., Elkhart, Ind., modernized lighting in its main offices and plant engineering department. The installation won a $100 award in the competition sponsored by the Second International Lighting Exposition.

Previously the lighting system in the main office had consisted of 300-watt incandescent fixtures of the indirect type. With these fixtures the average intensity was 10 to 12 foot-candles. This low intensity of illumination was the subject of continuous complaints.

An attempt had been made during the preceding year to modernize the lighting in the engineering department by installing four-tube, 40-watt suspended fluorescent units. When first installed these units provided an intensity of 75 foot-candles, but it soon fell off to the 40 to 50 foot-candle level.

This drop in intensity was caused by dust that originated in an adjacent production area and collected in excessive amounts on the fixtures. An unusual amount of work was required to keep the fixtures clean. And the draftsmen complained if they were left dirty.

It was decided (1) to raise the foot-candle intensity level in the main office to at least 35 foot-candles; (2) to eliminate the extreme drop in intensity in the engineering offices by selecting some other unit or type of lighting.

Enclosed Units Chosen

After experimenting with open-tube suspended units and open and enclosed troffer units, it was decided to install the latter type in both offices.

The spacing was to be varied

MAIN OFFICES. Fluorescent lighting in enclosed troffer units replaced former incandescent installation. Old level of 10 to 12 foot-candles has been raised to a level of 40 to 50-foot-candles, a lighting intensity that is satisfactory for work being done

AND MAIN OFFICE

so as to obtain the levels of illumination that were required in the different areas.

Recessed troffer units fitted in well with the construction in the main office, where the ceiling consists of 12-in. metal acoustical blocks.

It was also decided to lower the ceiling in the engineering department and install acoustical blocks in that area.

Symmetrical layout of the fixtures in the main office areas was not always possible because of steel joists that were placed on 16-in. centers. These joists did not always line up so that fixtures would be equally spaced from partitions, which were installed without regard to the spacing of the joists. In all except a few instances however, a good degree of symmetry was obtained by the use of 16-in. tile in place of the 12-in. blocks. Only those blocks that were to be replaced by a new lighting fixture were removed.

Satisfactory Illumination

In the main office building a level of 40 to 45 foot-candles is being maintained. In the engineering department the intensity of the lighting is 80 to 85 foot-candles.

Since this intensity is being held after a 5-month period, it appears that the glass-enclosed troffer unit has effectively solved the dirt problem in this area.

In both the office and the engineering department morale and efficiency are high, as a result of the modernization program.

The 45-deg. angle layout of fixtures in the drafting room presents a novel and attractive design. More important, it has eliminated all shadows on the drafting boards.

In several of the executive offices the placing of fixtures was worked out and the switching arranged so that it is possible to use all or part of the fixtures in the room, as required by the amount of natural light, without sacrificing even distribution of light in the area.

OPERATING SHORTS

Readers are invited to contribute brief articles, illustrated when possible, reporting out-of-the-ordinary operating accomplishments. Accepted articles will be paid for

A FREE-SWINGING TOP-HINGED DOOR extending across the width of the crane bay at the Downington Manufacturing Company, Downington, Pa., allows the overhead 10-ton traveling bridge crane to pass in and out of the building. Curved steel deflectors attached to the crane act as bumpers, and push the door up and hold it in a horizontal position as the crane comes out of the building. Once the crane has cleared the opening either way, the door drops back into place. Uncomfortable drafts in cold weather are thus minimized

SEWING ATTACHMENT INSURES ACCURACY

Sewing machine operators at Charis Corporation, Allentown, Pa., seam and plain stitch on the same machine. Plain stitching requires no mechanical guide. Seaming, on the other hand, is done to precise widths, and does require a guide.

BEFORE. A seam and plain-stitch operator would have to adjust the seaming guide at least 32 times a day. To do so, she attached, by means of a screw, a small metal guide to the metal work surface of the machine base to the right of the needle. Correct adjustment necessitated accurate measurement of the space between the needle and the guide. For plain stitching, the guide had to be removed. The time required to attach and remove the guide averaged 30 seconds.

NOW: The machine has a guide attached to the presser foot. This guide, equipped with a pivot pin, can be put in either the seaming or the plain-stitching position merely with a flick of the finger. It is a permanent attachment, and it never needs adjustment.

RESULTS: Seams are now always produced at an accurate and even measurement. Each attachment is used about four times an hour. Figuring 30 seconds saved, 32 times a day, on 60 machines, a saving of about 16 operator-hours per day is achieved. Production, quality, and uniformity of product have been improved. Operators have increased their earnings. The attachments paid their cost in a short time and dual-purpose machines help balance the production flow.

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INDIVIDUAL NAME PLAQUE BOOSTS EMPLOYEE MORALE

G. R. MOORE, Personnel Department, Schramm, Inc., West Chester, Pa.

Every employee in the company has an individual name plaque to identify him in his department. It consists of a wood strip in walnut finish on which are imprinted his name and date of employment. Veterans' plaques also show a silver service star.

In each operating department the plaques are hung in order of seniority on carved wood shields varying in size and hook space to accommodate the size of the department. Some shields can hold as many as 50 plaques. Each shield bears the department name at the top, and is kept in a prominent place on the wall. Plaques for office employees are kept on their desks.

When the indoctrination of new employee has been completed, the personnel department introduces him to his foreman by handing the foreman the new name plaque. The plaque is added immediately to the department shield. This always makes the new employee feel that he "belongs," and helps everyone to get acquainted.

The custom has other enduring benefits, such as recognition of long service and a continuing personnel inventory.

WIRE RECORDERS SPEED INVENTORY WORK

Savings in time and manpower have been effected by Navy Supply Corps personnel through the use of magnetic wire recorders for taking stock inventories. The new system was originated at the Supply Department of the Naval Shipyard, Norfolk, Va. As the checker works along the shelves, he carries a hand microphone, and "talks" his report into a permanent record for later transcription.

The usual system of taking inventory has been for two men to team up, the checker calling off the items to a recorder, who manually lists the counts on inventory sheets. Besides being slower, this system leads to frequent misunderstandings and transpositions of stock numbers, which, in turn, re-

quire time-consuming rechecks of shelves.

In a speed test with the wire recorder, checkers counted 100 items in 15 minutes. This compares to the previous figure of about 400 items a day using the two-man team.

•

AN IDEA borrowed from chain stores saves considerable time in gathering small parts for non-standard-sized orders at The Weatherhead Company, Cleveland. Order clerks in the jobbing division are provided with an order sheet and a light "picker" basket, which they push from shelf to shelf, filling the order just as the housewife fills her grocery order in the modern self-service food store. The order completed, the basket is pushed back to the packing desk, where the small cartons are assembled in a regular container for shipment

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REFRESHMENT PROFITS GO TO SUNSHINE FUND

C. M. DANNENBERG, Personnel Department, Schramm, Inc., West Chester, Pa.

The refreshment concession at Schramm is held by the employees, who periodically appoint a standing committee to govern its operation.

Refreshments for all shop and office employees are obtainable at any time during working hours. They can be purchased at a centralized location known as "The Cage," which otherwise functions full-time as a maintenance toolroom. Two stockmen take care of the dual duties of toolroom work and refreshment sales. Soft drinks, milk, candy, gum, crackers, and similar packaged items are sold.

All the profits of this concession belong to the employees, and are pledged to their "Sunshine Fund." This fund automatically takes care of the cost

UP-ENDER ON LIFT TRUCK SPEEDS TIERING OF ROLLS

Two men and two fork-lift trucks now do the work of five men and two hand trucks at Dixie Cup Company, Easton, Pa. By tiering with these lift trucks, the plant has saved 15,000 square feet of floor space. Rolls of paper, 32x54 inches, weighing one-half ton, are tiered three high.

One truck unloads boxcars and tiers the rolls. Another moves selected rolls from the tier to an automatic hoist at ground level for vertical transport to the third floor.

The latter truck is equipped with an up-ending device. Rolls are taken from the tier in vertical position and turned to horizontal at the hoist. They roll off the hoist by gravity.

This way the job is done much more quickly than before. Fewer accidents result and labor costs of three men are saved.

PACKAGING OF ACCESSORIES is made easier by the special table used at Emerson Electric Manufacturing Company, St. Louis. The table is divided into sections by painted stripes. The name of the part is stenciled in each space. Parts are first laid out single on the spaces from the storage bins in back; then they are gathered and placed in the shipping container in the predetermined order of packing. It used to be that parts were duplicated or left out completely in the "parts kit." Now mistakes are practically eliminated, and the work is being done more efficiently

of fruit or flowers to sick employees, also expressions of condolence and flowers in case of bereavement. The necessity for special solicitations for these purposes has been thereby eliminated. Employees patronize their own business venture freely and without mental reservation.

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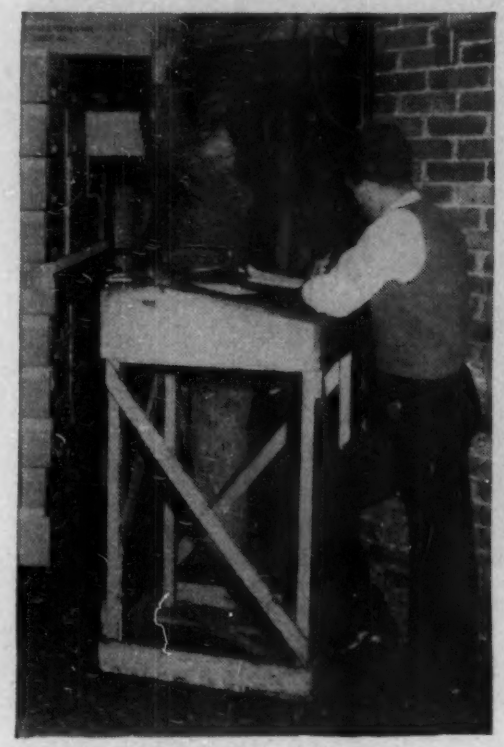

"TALLY TABLES" SERVE SHIPPING DOCK

Rolling "tally tables" now enable shipping clerks to handle outgoing shipments twice as fast at Day-Brite Lighting, Inc., St. Louis.

Before, shipping clerks had to write shipment orders and directions on any hard surface available—boxes, walls, and the like. Now they merely roll a "tally table" up to the loading platform and make notations as the carriers are loaded. Having ten loading doors, with better than half in use all the time, four clerks can now handle the work that required eight before. Tables have a flat area on top for rubber stamps, label moisteners, and pads of shipping slips. The inclined portion of the table allows for more comfortable writing.

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HOUSEHOLD HINTS, RECIPES ON EMPLOYEES' CALENDAR

The calendar distributed by the Youngstown Sheet & Tube Company, Youngstown, Ohio, to its customers is now made up for its own employees in smaller size for their home use.

Calendars are illustrated with photographs in color, depicting various operations throughout the company's plants. Each district is represented.

On the back of the calendar pages in the smaller "home edition" are printed recipes and household hints of all kinds. The pages are spiral bound so that either the colored picture on the front or the household hints on the back may be saved for future reference.

FOOD WAGONS PROVIDE BETWEEN-MEAL SNACKS

The food wagon is an integral part of the industrial relations program at White Sewing Machine Company, Cleveland. Two wagons, available to 1000 workers and serving about 800, start out each morning at 8:30 and return at 10:30.

A typical day's selection for the two wagons includes 11 dozen jelly rolls; 8 dozen glazed doughnuts; 18 dozen fried cakes; pies; about 7½ dozen cakes and rolls, such as cupcakes and bran muffins; 5 dozen sandwiches; 180 pints and 48 half-pints of milk; 36 pints of chocolate milk. Each wagon carries an 11-gal. thermos coffee container.

No profit is realized, or looked for, from the operation of these wagons. The company is satisfied to break even on food and labor costs.

HOURLY REST PERIOD UPS PRODUCTIVITY

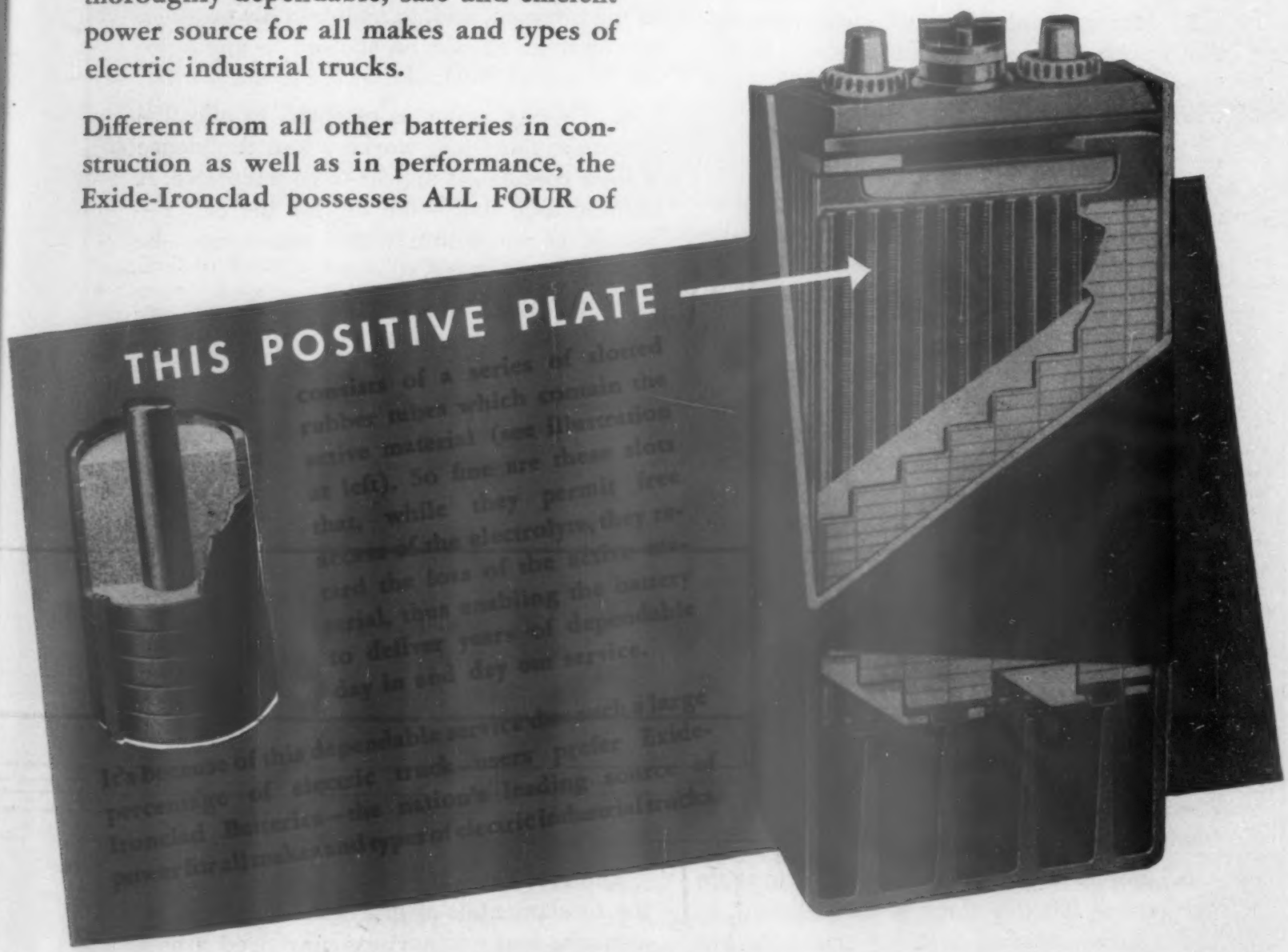
"Take five," says management to workers at Willys-Overland Motors, Inc., Toledo. So workers take a 5-min. rest every hour at five minutes to the hour. Assembly lines are stopped, and employees take time out for a smoke or to get a cup of coffee at one of the fifteen canteens spotted through the plant. The management knows the break each hour refreshes workers. And it is convinced that it pays off in increased productivity.

USERS EXPRESS PREFERENCE FOR Exide IRONCLAD BATTERIES

IN a recent national survey made by a leading industrial publication, 81.1% of electric industrial truck users expressed a preference for Exide-Ironclad Batteries.

Such overwhelming preference for the Exide-Ironclad Battery is based upon user experience. This unique battery has, during the past 35 years, proved itself to be a thoroughly dependable, safe and efficient power source for all makes and types of electric industrial trucks.

Different from all other batteries in construction as well as in performance, the Exide-Ironclad possesses ALL FOUR of the essential characteristics demanded of a battery for electric industrial truck service—(1) high power ability, (2) high efficiency, (3) great ruggedness, and (4) long life. These characteristics are due to the special construction of the Exide-Ironclad Battery, especially its rugged, tubular positive plate.



Write for further particulars and FREE copy of Exide-Ironclad Topics, which covers latest developments in material handling and shows actual case histories.

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